

**DRAFT**  
**SUPPLEMENTAL WORK PLAN**

**ADDITIONAL HYDRODYNAMIC DATA COLLECTION**  
**GEOTECHNICAL DATA COLLECTION**  
**SEDIMENT ACCRETION EVALUATIONS**  
**POREWATER SAMPLING AND ESTIMATION OF DISTRIBUTION COEFFICIENTS**

**PATRICK BAYOU SUPERFUND SITE, DEER PARK, TEXAS**

**Prepared for**  
USEPA Region 6

**On behalf of**  
Patrick Bayou Joint Defense Group

**Prepared by**  
Anchor Environmental, L.L.C.  
1423 Third Avenue, Suite 300  
Seattle, Washington 98101

**May 2007**



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## 1 INTRODUCTION AND PURPOSE

This Supplemental Work Plan describes a scope of work to provide additional data for risk characterization and Feasibility Study (FS) analyses at the Patrick Bayou Superfund Site in Deer Park, TX (Site). This Supplemental Work Plan was developed by Anchor Environmental (Anchor) on behalf of the Patrick Bayou Joint Defense Group (JDG). The JDG is signatory to the Administrative Settlement Agreement and Order on Consent and (AOC) with U.S. Environmental Protection Agency Region 6 (USEPA) dated January 31, 2006. The AOC concerns the performance of a Remedial Investigation/Feasibility Study (RI/FS) at the Site.

Many of the data collection activities that are recommended herein were originally outlined in the Scope of Work described in the General RI Work Plan submitted to the USEPA (Anchor 2007) as parts of Work Packages 3 and 4. The recommended field work was developed based on review of the results of Work Package 2 evaluations. Those evaluations focused on determining the vertical extent of preliminary contaminants of potential concern (COPC), evaluating sedimentation rates based on Cesium-137 marker horizons, and collecting hydrodynamic data. The scope of work in this Supplemental Work Package includes tasks that are designed to address outstanding data gaps in regards to porewater chemistry, provide a detailed analysis of the quality and rates of current sedimentation, and provide information that can be used in the evaluation of remedial alternatives.

The evaluations that are proposed as part of this Supplemental Work Plan were developed to provide information that can be utilized to further develop the Conceptual Site Model (CSM). The work plans for Work Package 3 (risk assessment) and Work Package 4 (feasibility study) are still planned for future submittals.

## 2 SAMPLING DESIGN AND RATIONALE

The recommended scope of work was specifically developed to help address data gaps concerning potential remedial actions at the Site that would involve sediment caps/covers, monitored natural recovery (MNR), or enhanced MNR (EMNR).

Data gaps associated with these remedial alternatives fall into the following four general categories:

1. Determination of hydrodynamic stability of bed sediments (Section 3.1)
2. Evaluation of recent sediment quality and accumulation rates (Section 3.2 and Section 3.3)
3. Evaluation of geotechnical properties of potential capping areas (Section 3.4)
4. Evaluation of contaminant flux from porewater into clean cover materials (either natural or imported cover materials) and surface water (Section 3.5)

The following provides a discussion of the objectives and details of the proposed scope of work for each of these categories. A proposed schedule of field and laboratory activities is provided in Appendix A.

### 3 SCOPE OF WORK

#### 3.1 Determination of the Hydrodynamic Stability of Bed Sediments

The proposed Work Plan for the determination of the hydrodynamic stability of bed sediments corresponds to the Phase 3 Sediment Transport Modeling described in the General RI Work Plan. This work builds upon the hydrodynamic data collection and preliminary modeling that was completed for the Site as part of Work Package 2. The objectives of the proposed modeling and evaluation include the following:

- Evaluate the effect of high-flow events on bed stability in the Site, which includes determining areas of potential scour and depth of scour in those areas
- Evaluate the fate of eroded sediment during high-flow events
- Determine the potential for natural recovery within the Site due to surface-layer sediment by deposition of incoming sediment loads and to characterize the quality of incoming sediment
- Use model results for work related to the FS (e.g., predicted current velocity or bed shear stress values for potential sediment cap designs)

Work conducted during this phase of the study consists of the following primary tasks:

- Extend the existing numerical grid used in previous work beyond the mouth of the Site to account for tidal and downstream flow effects
- Collect field Sedflume data to develop, calibrate, and validate the sediment transport model
- Use the sediment transport model to evaluate: 1) the effects of high-flow events and 2) the potential for natural recovery due to deposition of incoming sediment loads
- Revise the CSM as needed

##### 3.1.1 Expansion of Numerical Grid

The present numerical grid for the Site hydrodynamic model ends at the mouth of Patrick Bayou. Results of hydrodynamic simulations conducted with this numerical grid indicate that the model may not accurately predict the circulation patterns in the region near the confluence of the Site and the Houston Ship Channel (HSC). The predictive capability of the model in this region of the Site can be improved by extending the numerical grid from the mouth of the bayou. Expanding the spatial extent of the modeling domain will make it possible to more realistically simulate the

hydrodynamic circulation patterns in the vicinity of the mouth of the Site. After the revised numerical grid is constructed, numerical testing of the hydrodynamic model will be conducted to ensure the model is working properly with the new grid. In addition, the hydrodynamic calibration simulations will be repeated to check that the revised grid did not affect the calibration results.

### **3.1.2 Sedflume Data Collection**

Development of a sediment transport model will require the collection of site-specific data related to the erosion properties of Site sediments. A device called Sedflume has been used at a number of contaminated sediment sites to measure erosion rates and critical shear stresses of fine-grained, cohesive sediment. USEPA has requested use of Sedflume data in sediment stability studies at other sites (e.g., Lower Duwamish Waterway, located near Seattle, Washington). The proposed Sedflume study would be conducted by Sea Engineering, Inc. (SEI), which is located in Santa Cruz, California.

The objective of the Sedflume study is to characterize the erosion rates and stability of sediments throughout the region of interest. Sediment characteristics, such as mean particle size, particle size distribution, and bulk density will be determined with depth for each core obtained. The information collected in this study can be used to provide parameters for a sediment/contaminant transport model to estimate storm-induced resuspension of sediment and subsequent release of contaminants.

The direct measurement of sediment erosion rates via Sedflume provides a quantitative measurement of sediment stability that can be used to determine the potential for sediment mobility in a natural system (McNeil et al. 1996). A detailed description of Sedflume and its application is presented in McNeil et al. (1996). A schematic of a Sedflume is shown in Figure 1; it is essentially a straight flume that has a test section with an open bottom through which a rectangular cross-section coring tube containing sediment can be inserted. The main components of the flume are the coring tube; the test section; an inlet section for uniform, fully-developed, turbulent flow; a flow exit section; a water storage tank; and a pump to force water through the system. The coring tube, test section, inlet section, and exit section are made of clear acrylic so that the sediment-water interactions can be observed. The coring tube shown in Figure 1 has a

rectangular cross-section, 10 centimeters (cm) by 15 cm, and can be up to 1 meter in length.

Water is pumped through the system from a 120-gallon storage tank, through a 5-cm diameter pipe, and then through a flow converter into the rectangular duct shown. This duct is 2 cm in height, 10 cm in width, and 120 cm in length; it connects to the test section, which has the same cross-sectional area and is 15 cm long. The flow converter changes the shape of the cross-section from circular to the rectangular duct shape while maintaining a constant cross-sectional area. A three-way valve regulates the flow so that part of the flow goes into the duct while the remainder returns to the tank. There is also a small valve in the duct immediately downstream from the test section that is opened at higher flow rates to keep the pressure in the duct and over the test section at atmospheric conditions.

At the start of each test, the coring tube is filled with undisturbed sediments from the bottom of the body of water of interest or reconstructed sediments for consolidation studies. The coring tube and the sediment it contains are then inserted into the bottom of the test section. An operator moves the sediment upward using a piston that is inside the coring tube and is connected to a screw jack with a 1-meter drive. The jack is driven by either electric motor or hand crank. By these means, the sediments are raised and made level with the bottom of the test section. The speed of the jack movement is controlled at a variable rate in measurable increments as small as 0.5 mm.

Water is forced through the duct and the test section over the surface of the sediments. The shear produced by this flow causes the sediments to erode. As the sediments in the core erode, they are continually moved upwards by the operator so that the sediment-water interface remains level with the bottom of the test and inlet sections. The erosion rate is recorded as the upward movement of the sediments in the coring tube over time.

Sedflume analysis will be undertaken by SEI to determine sediment erosion rates at the Site laterally and with depth at sites shown in Figure 2. Sedflume cores up to 1 meter in length will be collected from the Site and the erosion rate tests conducted at a location adjacent to the Site. Processing and testing of the cores will occur at the Site location so

that the cores are minimally disturbed prior to the Sedflume tests. Because erosion rates are strongly dependent on the bulk density of the sediments (Jepsen et al. 1997; Roberts et al. 1998), the densities of materials in the Sedflume cores will be determined at intervals within each core so that the wet bulk density can be determined through wet/dry sample weight. Particle size analysis will also be performed at subsampled locations in the cores to provide additional characterization of the sediments.

Figures 3 and 4 show sample Sedflume data from independent studies conducted at test sites in San Francisco Bay by SEI. Figure 3 shows the variation of sediment erosion rates with depth into the sediments and shear stress. This plot shows that the surficial sediments erode easily compared to sediments that are at deeper intervals in the core, which require larger shear stresses to induce erosion. Figure 4 shows particle size and bulk density variation for the same core as Figure 3.

Data collected in the Sedflume study will be summarized in plots of the following:

- Erosion rate versus core depth
- Bulk parameters (e.g., bulk density) versus core depth
- Average erosion rates and average bulk properties with binned depth

General trends in the dataset will be noted and variations between different regions will be characterized. Quality assurance objectives and results will be assuaged in the process of preparing a final data report. Measurements to be made by SEI are shown in Table 1. These measurements will be made by instrumentation provided by SEI's laboratory.

#### *3.1.2.1 Sedflume Data Quality Objectives for Measurement Data*

To achieve the project's overall data quality objectives, measurements will be made to ensure sufficient characterization of sediment bulk properties and erosion rates. The bulk properties to be measured by SEI have been chosen based on previously determined field and laboratory work (McNeil et al. 1996; Taylor and Lick 1996; Jepsen et al. 1997; and Roberts et al. 1998). The parameters to be measured in the Sedflume cores are listed in Table 1.

The erosion rates of the sediments as a function of shear stress and depth will be measured by sediment cores obtained as described above and then moved upward into the test section until the sediment surface is even with the bottom of the test section. A measurement is made of the depth to the bottom of the sediment in the core. The flume is then run at a specific flow rate corresponding to a particular shear stress. Erosion rates are obtained by measuring the remaining core length at different time intervals, taking the difference between each successive measurement, and dividing it by the time interval.

In order to measure erosion rates at several different shear stresses using only one core, the flume is run starting at a low shear stress, and then sequentially at higher shear stresses with each succeeding shear stress being twice the previous one. Generally, about three shear stresses are run sequentially. Each shear stress is run until at least 2 to 3 millimeters (mm) but no more than 2 cm are eroded. The time interval is recorded for each run with a stopwatch. The flow is then increased to the next shear stress, and so on until the highest shear stress is run. This cycle is repeated until all of the sediment has eroded from the core. If after three cycles a particular shear stress shows a rate of erosion less than  $10^{-4}$  cm/second (s), it will be dropped from the cycle. If after many cycles the erosion rates decrease significantly, a higher shear stress will be included in the cycle.

#### *3.1.2.2 Measurements of Critical Shear Stress for Erosion*

A critical shear stress can be quantitatively defined as the shear stress at which a very small, but accurately measurable, rate of erosion occurs. For Patrick Bayou, this rate of erosion is chosen to be  $10^{-4}$  cm/s; this represents 1 mm of erosion in approximately 15 minutes. Since it would be difficult to measure all critical shear stresses at exactly  $10^{-4}$  cm/s, erosion rates are generally measured above and below  $10^{-4}$  cm/s at shear stresses that differ by a factor of two. The critical shear stress is then linearly interpolated to an erosion rate of  $10^{-4}$  cm/s. Critical shear stresses will be measured as a function of depth for both the field and the laboratory sediment cores.

### ***3.1.2.3 Measurements of Sediment Bulk Properties***

Particle size and bulk density measurements will be conducted using standard laboratory analyses. These include wet weight, percent moisture as water content (ASTM D 2216), dry weight, total organic carbon content (EPA Method 9060), and grain size (ASTM D 422). Results of these determinations will be used in the interpretation of sediment shear stress, erosion, and accretion data.

### ***3.1.2.4 Sedflume Testing Quality Control Requirements***

Quality control will be performed routinely during sampling and measuring. Sediment erosion rates are related to shear stresses that are applied at particular flow rates in the channel of the Sedflume. The initial flow rate used will be that at which sediment erosion is observed to begin. The flow rates, as measured by the flow meter, will be checked daily by directly measuring the volume of water collected over time at the outlet of the channel. If the flow rates are not correct, the paddle wheel of the flow meter will be cleaned and inspected. If this does not correct the problem, a new flow meter will be installed.

All instruments used for bulk density analysis will be tested with standard materials before and after each testing period. Particle size measurements will be run in duplicate to check for accuracy. Also, known standards will be measured before and after each testing period.

### ***3.1.2.5 Instrument/Equipment Testing, Inspection and Maintenance Requirements***

The Sedflume flow rates and all instrumentation will be tested daily before each test run. The particle size measurements will be tested against known standards.

Sedflume is designed as a field device and as such is a fairly robust system. Spare parts for Sedflume and for the coring operation are available at any hardware store, or may be made by any competent machine shop.

### ***3.1.2.6 Instrument Calibration and Frequency***

No instruments used in the Sedflume study require calibration. All instruments will be tested as described previously.

### **3.1.3 Sediment Transport Modeling**

The sediment transport model used in this study is SEDZLJ, which is a model that QEA personnel have helped to develop over the last 20 years. This model is capable of predicting the erosion, deposition, and transport of fine-grained sediments (i.e., clay, silt and fine sand), which is the primary type of sediment found at the Site. SEDZLJ is unique because it is capable of using site-specific erosion rate data obtained from Sedflume measurements. Note that SEDZLJ is linked directly to the hydrodynamic model within the framework of the Environmental Fluid Dynamics Code (EFDC) computer model. This model has been utilized at other Superfund sites including: Lower Duwamish Waterway (Washington), Holston River (Tennessee), Lower Fox River (Wisconsin), and Hunter's Point (San Francisco Bay).

The first step in developing and calibrating the sediment transport model will be to analyze the erosion rate data collected during the Sedflume study. The data will be analyzed and used to specify erosion rate parameters used in the model. Spatial variability in the Sedflume data will be examined so that vertical and horizontal variations in the data can be properly represented in the model. Sediment loading to the Site is the other important model input parameter that must be specified. Since the sediment rating curve developed from the total suspended solids (TSS) concentration and flow rate data collected during the October 2006 Work Package 2 field study provides reliable estimates of incoming sediment loads; the rating curve will be used to specify inputs for the sediment transport model.

The sediment transport model will be calibrated using TSS concentration data collected during the Work Package 2 October 2006 field study. Three storms occurred during that period and elevated TSS concentrations were measured at the inflows to the Site and also at a sampling location near the mouth of the bayou (i.e., station PB003) during the storms. This is an excellent dataset for calibrating the sediment transport model. The model will be validated through comparison of predicted net sedimentation rates to values estimated from the analysis of the geochronology cores obtained and evaluated during Work Package 2. A multi-year simulation will be conducted using the calibrated model. Predicted bed elevation changes in the bayou at the end of the multi-year period

will be converted to net sedimentation rates (i.e., cm/year) for depositional areas of the Site. The predicted and estimated net sedimentation rates at the locations of the geochronology cores will then be compared. In addition to the quantitative validation of the model, qualitative validation will be accomplished through comparison of the spatial distribution of predicted bed elevation change to measured bed thickness. This qualitative comparison will evaluate the ability of the model to predict large-scale changes in bed elevation (e.g., does the model predict relatively high net sedimentation in areas of highest bed thickness?).

The calibrated model will be used to evaluate the effects of high-flow events on sediment transport and bed stability within the Site. The high-flow events (e.g., 100-year flood) evaluated during Phases 1 and 2 using the hydrodynamic model will be repeated with sediment transport being simulated. For each high-flow event, the model will predict the following: 1) TSS concentration; and 2) bed elevation changes (scour and deposition). Model results will be presented as two-dimensional maps of the distribution of bed elevation changes throughout the bayou at the end of the high-flow event. Mass balances of the study area, or various portions of it, will be constructed to develop an understanding of sediment transport processes within Patrick Bayou during rare storms. The mass balance results will be used to determine if net export of sediment from the bayou to the HSC occurs during high-flow events. In addition, it is possible to ‘tag’ sediment particles in specific regions of the bayou and predict the fate of those tagged particles during a high-flow event.

Another use of the sediment transport model is to evaluate long-term sedimentation rates within Patrick Bayou. For this type of analysis, the model will be used to simulate a multi-year period and predict the spatial distribution of bed elevation changes throughout Patrick Bayou. The length of the multi-year period will be determined after the sediment transport model is developed and calibrated. The simulation period is dependent on the computational burden of the Patrick Bayou model and cannot be determined at the present time. The length of the multi-year simulation will be maximized with the goal being to limit the computational time to five days. The first step in the multi-year simulation is to use the watershed model to predict the inflows to the Site. Next, the hydrodynamic model will simulate circulation in the bayou and the

HSC. Finally, the sediment transport model, using transport information from the hydrodynamic model, will simulate the erosion, deposition, and transport of sediment in the system. Results of the multi-year simulation will be used to evaluate the effect of sediment transport processes on the rate of natural recovery in the bayou. In addition to predicting bed elevation changes (e.g., net deposition and erosion), mass balances for the bayou will be constructed to quantitatively evaluate the transport of sediment into and out of Patrick Bayou, or specific regions of the bayou.

### **3.2 Accretion Evaluations**

The vertical profiling data conducted as part of Work Package 2 indicates that long-term sedimentation rates in depositional areas of the Site range from 2 cm/yr to over 3 cm/yr. These rates were established by identifying Cesium-137 marker horizons that correspond to the years 1953 and 1964. The bulk chemistry data from the vertical profiling evaluations and Cesium-137 data from Work Package 2 clearly indicate that sediment deposition has occurred at a significant rate over the past 50 years; however, there is a possibility that net long-term sedimentation rates (natural recovery rates) were affected by changes in land use and subsidence over time.

The recommended program for the evaluation of recent sediment accumulation rates described below is designed to better identify recent and current rates of sedimentation at the Site. The following scope of work was developed to compliment and help calibrate the Site hydrodynamic modeling described in Section 3.1 above.

#### **3.2.1 Lead-210 Age Dating**

To refine and compliment the net sedimentation rate data that was developed for the Site using Cesium-137 analyses from Work Package 2, the evaluation of recent sedimentation rates involves the analysis of Lead-210 in shallow sediments. This method of age dating sediments is described by Jeter (2000). Lead-210 is a natural radioactive form of lead, which is found in small quantities in most soils as part of the uranium decay series. It is also produced as natural fallout from the atmosphere by radioactive decay of Rn-222 (radon-222) gas. Minute quantities of Lead-210 fall constantly onto the earth's surface. This material accompanies and mixes with sediments, which accumulate at the bottoms of water systems. For a given locality, the

supply of Lead-210 is often at a steady rate, being derived from direct deposition, from upstream transport, and from decay of Rn-222 in the water. The result is a relatively high concentration of Lead-210 in the shallow sediments (Jeter 2000).

Because of radioactive decay, excess Lead-210 (derived from natural fallout) is generally detectable to 100 years before the present. At depths corresponding to 100 years or older, the excess Lead-210 has decayed away and the measured concentration represents the background level which is characteristic of the sediment itself. If a logarithmic curve is fitted to a complete Lead-210 profile from the surface to the 100 year level, the sedimentation rate derived from the slope of the line represents an average over a 100 year time frame. In areas where sedimentation rates have varied over time, different slopes can be identified in the Lead-210 concentration plots allowing varying sedimentation rates to be derived.

### **3.2.2 Lead-210 Sampling and Analysis Methods**

The cores that were collected for the Cesium-137 analyses in Work Package 2 were sectioned into 4-cm intervals and archived for potential future analysis of Lead-210. The recommended analysis involves conducting a Lead-210 evaluation on archived materials from the radiochemistry cores collected during the Work Package 2 field investigation.

Because the viability and success of being able to interpret Lead-210 data is normally site-specific, the initial proposed analysis will focus on three samples per core to assess if the method is appropriate for the Site. Previously collected 4-cm interval samples from cores PB003, PB022, PB036, PB048, and PB057 will be analyzed for Lead-210 (locations of these cores from Work Package 2 are shown on Figure 5). Initially, an archived sample interval in the top, middle, and bottom third of each core will be analyzed. The precise interval to be analyzed in each core will be determined based on professional judgment, the availability of archived intervals, and the previously determined Cesium-137 vertical profile. In addition, the background “supported” level of Lead-210 that is attributed to sediment particles will be analyzed in the deepest intervals from cores PB057 and PB048. This value is subtracted from each of the upper core interval analyses to calculate excess Lead-210 from natural fallout. If analysis of data from the initial samples provides acceptable results based on the proposed three intervals, additional intervals from the

archived cores will be analyzed to fill data gaps for more precise interpretation of the recent depositional history at the Site.

### **3.2.3 Sediment Marker Horizons**

High-resolution measurements of vertical accretion of shallow water sediments will help develop a better understanding the processes that control elevation change at the Site and the mechanisms of sediment accumulation (e.g., development of mudflats and intertidal wetlands).

The following approach for establishing ongoing sedimentation rates in Patrick Bayou was developed based on methods utilized by the United States Geological Survey (Cahoon et al. 2000, 2002a, 2002b). This approach has gained wide acceptance in coastal restoration evaluations and in academia, and is ideally suited for collecting data that can be used to calibrate the sediment transport model and predict future sedimentation rates in different areas of the Site.

The approach described in this section measures vertical accretion from marker horizons with sediment cores collected with a cryogenic coring apparatus.

#### **3.2.3.1 Accretion Measurement Methods**

##### **3.2.3.1.1 Vertical Accretion**

The proposed method for measuring vertical accretion involves periodically recording the rate of accumulation of sediment above a marker horizon (such as white feldspar or sand) that is laid upon the bottom sediments (Cahoon and Turner 1989). A wooden platform is built to allow access to the Site bottom while minimizing disturbance. Three marker horizons (Figure 6) are laid at each platform, thereby providing a visual reference datum of the bayou bottom at the start of the study as well as a means for directly correlating accretion measurements. Vertical accretion is determined from soil cores collected by a cryogenic coring apparatus (Cahoon et al. 1996; Figure 7). Cryogenic coring makes direct measures of vertical accretion feasible in shallow water environments because freezing bottom sediments in place eliminates compaction during coring and loss of flocculent material when removing the core through

overlying waters. In addition, freezing permits 1) collection of small-diameter cores, which minimizes disruption of the marker horizons; and 2) immediate examination and measurement of the core, thereby ensuring data quality.

Accretion/sediment accumulation rates will be measured by the establishment of up to eight 1/2-meter by 1/2-meter marker horizon stations (Figure 8, Table 2a). The marker horizon will be either a white feldspar clay, or white sand that is evenly sprinkled on the surface of the sediment. At 6 and 12 months after establishment, the stations will be sampled using the cryogenic method developed by Cahoon et al. (1996).

Procedures for constructing and collecting sediment accumulation measurements will generally follow those recommended by Cahoon et al. (1996, 2000, 2002a, 2002b) and the *Standard Operating Procedures Manual For The Louisiana Department of Natural Resources Coastal Restoration Division* (Folse and West 2004). Those procedures are outlined in Appendix B. Some modifications to the procedures may be made depending on site-specific conditions within Patrick Bayou.

### **3.3 Upstream Sediment Trap Evaluations**

Sediment traps will be used to sample suspended particulate material in Patrick Bayou. Chemical analysis of the suspended particulate will provide an indication of the quality of sediment that is currently being deposited in Patrick Bayou. These data, evaluated in conjunction with sediment accretion data, will provide an indication of the potential for natural processes to reduce contaminant concentrations in surface sediment.

Sediment trap sample locations were selected as far upstream as practical in the East Fork and the main channel of the Site to collect samples representative of new sediment introduced into the study area. Two locations were selected, one to collect suspended sediment entering the site from the south (the City of Deer Park) in Patrick Bayou and another to collect suspended sediment entering the site from East Fork. The locations, at stations EF001 and PB077, are shown on Figure 8. Coordinates are given in Table 2a.

Sediment trap design is regulated primarily by the following factors:

- Water depth
- Surface water flow patterns around the traps
- Suspended particulate load
- Required sample volume

An evaluation of water depth at the selected sample locations indicates that the shallowest water depth is typically 12 to 18 inches. The water column above the sediment trap should be at least equivalent to the height of the trap itself to collect a representative sample of suspended particulate. To avoid biasing the sample in a flowing stream, the sediment trap configuration should not create flow patterns that would discourage certain particles from entering the trap (such as a traps shape or obstructions that would cause upward flow above the aperture that would winnow less dense particles and selectively sample denser particles). The depth to aperture ratio for sediment traps should be at least 5-to-1 to provide adequate capacity for collecting sediment while minimizing potential loss of sediment from traps due to turbulent flow near the mouth of the trap. The traps must have adequate capacity to collect sufficient sample to perform the required analyses. The trap capacity needs to be balanced with the deployment period and settling rate so the collected sediment does not fill the traps. Ideally, the traps will fill no more than halfway to avoid possible loss of sediment later in the deployment period.

The sediment traps for the current investigation are cylinders—sample jars—approximately 6 inches tall. To achieve the desired depth to aperture ratio, the aperture will be reduced to approximately 1 inch by deploying the jar traps with lids that have been prepared by cutting a 1-inch-diameter circular hole in the center. The traps will be deployed in racks of six jars, one assembly at each sample location, to collect sufficient sample. A schematic diagram of a sediment trap sampler assembly is shown on Figure 9. An average of 0.25 inches of sediment will be needed in each trap to collect sufficient sample for the required analyses. The traps will be anchored to the sediment bed with a steel pipe (approximate diameter 2 inches) driven into the bed. The two trap cylinders will be fixed perpendicular to the current. The traps will be positioned in water depths of at least 12 inches, such that the height of water over the aperture is equal to or greater than the height of the trap cylinders (i.e., minimum 6 inches of overlying water).

Prior to deployment, each trap cylinder will be filled approximately half way with high-salinity water (4 percent NaCl) containing 2 percent buffered formaldehyde (5 percent buffered formalin) as a preservative to reduce biofouling and biochemical degradation in the traps. The relatively high density of the saline solution (compared to the density of ambient water) helps to retain the solution and the sample in the traps. The remaining volume in the traps will be filled with ambient water prior to submersion to prevent turbulence and loss of solution. The conductivity of the water in the bottom of the traps will be measured and recorded prior to submerging the traps. Upon retrieval, before the contents of the trap are transferred to sampling containers, the salinity of the bottom water in the traps will be checked to assess the degree to which the preservative solution has been retained in the traps.

The sediment traps will be deployed for approximately four weeks. The date and time that the sediment traps are deployed, as well as the conductivity of the bottom water in the traps, will be recorded in the field log. At the end of the anticipated deployment period, the accumulation of sediment in the traps will be checked to determine whether there is sufficient volume of material for the required analyses. The traps will also be inspected for excessive biofouling. If sufficient sediment (6 ounces per location for all analyses) has accumulated, the sediment traps will be removed to retrieve the sample. This required volume of sediment equates to approximately 0.25 inches of sediment in each of the six jars in the sediment trap assemblies. If insufficient sediment has accumulated, the traps will be resubmerged until a sufficient volume of sediment has accumulated or it is determined that biofouling may compromise the representativeness of any further deployment. A total of six deployments spanning a minimum period of 6 months are planned at each location.

When sufficient sediment has been collected in a trap for the required chemical analyses, the sediment trap will be removed from the sampling stations, taken to a processing area, and secured to allow the sediment to settle to the bottom of the trap. The time and date that the sediment traps are removed from the bayou will be recorded in the field log. The clear water will be decanted from the traps using a peristaltic pump, entraining as little of the sediment as possible. The remaining water and all of the sediment from each trap will be transferred to a container for delivery to the analytical laboratory. The laboratory will

centrifuge the contents and determine the total dry solids collected, thus providing estimates of the mass accumulation rate at each station. The sediment will be analyzed for the following parameters:

1. Polynuclear aromatic hydrocarbons (PAH) and phthalates
2. Polychlorinated biphenyl (PCB) congeners
3. Mercury and other metals (arsenic, barium, cadmium, chromium, copper, lead, nickel, selenium, silver, and zinc)
4. DDT (DDT analyses may be omitted if insufficient sample is collected)

These constituents occurred at significant concentrations in samples from upstream areas in previous TMDL and RI evaluations. Other constituents, such as dioxins/furan, hexachlorobenzene (HCB), hexachlorobutadiene (HCBD), and chlorobenzene have occurred at very low or non-detectable concentrations in upstream areas in both the recent Work Package 2 and historical evaluations. Table 2b summarizes proposed sampling locations and analytes for sediment collected in the upstream sediment traps. Modifications to the sediment trap procedures may be made depending on site-specific conditions within the Site.

### **3.4 Evaluation of Geotechnical Properties**

The assessment of potential sediment containment methods, such as in situ capping, requires information on the energy of the surface water flow in the area of interest, the mobility and concentrations of COPCs in the native sediment, and the strength and grain size of the native sediment. These data are used to evaluate potential capping materials for their resistance to erosion and their resistance to the flux of COPCs through the cap. The strength and grain size of the native sediment is required to assess the ability of the sediment to support the cap and to select the proper gradation of capping materials. The proposed geotechnical testing and evaluations below were developed to gather the information necessary to evaluate sediment stability and strength.

#### **3.4.1 Geotechnical Testing**

Specific geotechnical field measurements and tests that are required to evaluate capping and dredging alternatives include:

- **Geotechnical Index Properties.** Atterberg limits, moisture content, grain size, and specific gravity will be measured on selected samples representative of the range of sediment conditions in different areas of the Site.
- **Settlement Properties.** Sediment samples will be tested to evaluate settlement from placing caps over in situ sediments. Settlement properties are also required to properly size, design containment berms for, and predict the behavior of caps over aquatic confined disposal areas. Total settlement and time rate of settlement will be evaluated through laboratory testing of reconstituted sediment samples using the Seepage Induced Consolidation Test (SICT).
- **Strength Properties.** In situ strength of the sediments will be measured using field vane shear equipment. This information will be used to evaluate acceptable lift thicknesses of potential sediment caps. Strength will also be correlated to geotechnical index parameters and will be measured using laboratory tests on undisturbed samples if necessary.
- **Permeability Properties.** The permeability of the surficial sediment will be measured using the SICT. Permeability of the native underlying Beaumont Clay will be measured in the laboratory on undisturbed samples collected using a Shelby tube, using a Falling Head permeability test. This information will be used to support groundwater flow modeling for sediment caps.

Figure 10 and Table 3 provide a summary of proposed sampling locations and analytical methods for the proposed geotechnical testing program.

#### *3.4.1.1 Geotechnical Index Tests from SICT Cores*

Classification tests, including Atterberg limits, grain size, moisture content, and specific gravity, will be run on select samples that will be split from extra material generated during the collection of the SICT cores; five cores are proposed. Index tests will be run on representative samples determined in the field so that the results adequately characterize the geotechnical characteristics of the range of materials present in the study area. It is expected that seven to ten tests of each type will be sufficient to characterize the range of conditions; however, the final number of samples tested will be determined by an experienced geologist who will be preparing a log of the core during the field work.

#### *3.4.1.2 Permeability Testing and Classification of Beaumont Clay from Shelby Tube Sampling*

At Station PB030 a Shelby tube sample will be advanced in the field in order to collect an undisturbed sample of the Beaumont Clay beneath the surficial sediment. This sample will be analyzed for Atterberg Limits, grain size, moisture content, specific gravity, and permeability using the Falling Head test. In the event that the Shelby tube collects less than a 6-inch-long sample, the location of the sample will be changed and the Shelby tube will be driven at an alternate location until a sample of at least 6 inches in length is collected.

#### *3.4.1.3 SICT Locations and Testing*

Figure 10 presents the locations where SICT samples will be collected. SICT tests will be performed on selected representative sample intervals from each location. Intervals will be identified in the field by the project geotechnical engineer and will be composited into a single sample for each station location. For each sample, Atterberg limits and grain size (with hydrometer) will be performed in accordance with ASTM D4318 and D422, respectively, to classify the sample as described in Section 3.4.1.1. Based on the classification testing, one SICT will be performed for each distinct clay mineral that is present at the site. Up to five SICT tests may be performed; however, if the Atterberg limits and grain size results indicate that a common clay mineral is present in all samples, a reduced number of SICT tests will be performed. SICT testing will be performed in accordance with Zindarcic (1994).

#### *3.4.1.4 VST Locations and Testing*

Figure 10 shows the proposed locations for vane shear testing (VST). At each location, the vane shear device will be deployed and both peak and residual strength of the surficial sediment will be measured at the 1-foot, 2-foot, and 3-foot depth intervals below the mudline. Fifteen VST locations are targeted as shown on Figure 10. The VST will be operated using the standard procedures provided in Roctest (2005).

Some modifications to the procedures may be made depending on site-specific conditions within Patrick Bayou.

### **3.5 Contaminant Flux from Sediment Porewater**

An evaluation of the concentration and flux of contaminants from porewater in sediments into potential sediment caps and surface water is important for the following reasons:

- It will allow a better estimation of risk to benthos and aquatic wildlife, especially in regards to the evaluation of risk from methyl mercury.
- Site-specific distribution coefficients are required to evaluate the long-term effectiveness of sediment caps and covers (either natural or imported).

The primary preliminary COPC at the Site include PAHs, PCBs, dioxins/furans, pesticides, HCB, HCBd, phthalates, chlorinated benzenes, metals, and mercury. The solubility of these compounds is dependent on the amount of organic carbon in the system, and with the exception of mercury, they are generally insensitive to changes in oxidation/reduction (redox) potential. Mercury speciation and cycling, however, is highly dependent on redox conditions, and from an ecological and human health risk perspective, determination of the potential for methylation of mercury is important. The most drastic changes in redox and microbial community conditions that affect mercury cycling occur in near-surface sediments.

#### **3.5.1 Porewater Collection**

Because of the difference in the solubility controls between the organic COPC and mercury, and the importance of evaluating the methylation potential of mercury, the recommended scope of work includes separate sampling techniques to determine site-specific distribution coefficient data for these compounds. Furthermore, porewater collection for volatile organic compound (VOC) analysis will be performed using a different sampling technique to minimize volatilization during sampling.

##### **3.5.1.1 Metals, SVOC, Pesticides, and PCBs**

For the organic compounds and metals that are relatively insensitive to changing redox conditions, distribution coefficient data can be averaged over greater sediment depths. The biologically active zone at the Site has generally been assumed to be

from 0 to 11 cm in previous total maximum daily load (TMDL) and RI investigations (Parsons et al. 2002, 2004; Anchor 2007), so the recommended evaluations focus on characterizing bulk sediment and porewater concentrations in that zone at key locations within the Site. The following provides the procedures that will be used to collect and analyze for these data.

Surface sediment samples (0 to 11 cm) will be collected from stations shown on Figure 11 (coordinates given in Table 4). These locations were chosen so that porewater data would be available from areas that cover a range of representative chemical concentrations, habitats, and physical settings at the Site.

Before sampling begins at a station, all equipment used for homogenizing the sediment samples (i.e., stainless-steel or polytetrafluoroethylene [PTFE] bowls, and spoons) will be decontaminated following the methods outlined in the Work Package 2 Work Plan. All equipment and instruments used will be cleaned prior to each day's use and between sampling or handling following USEPA protocols (USEPA 2001):

- Pre-wash rinse with tap water or site water
- Wash with solution of tap water and Alconox soap (brush)
- Rinse with tap water
- Rinse three times with distilled water
- Cover (no contact) all decontaminated items with aluminum foil
- Store in clean, closed container for next use

A hexane rinse may be added to the above list if there are significant residues observed on field equipment.

Each sediment grab will be documented and the following will be noted in the field logbook:

- Date and time
- Station identifier
- Sampling crew
- Sampling vessel

- Sampling method
- Weather
- Station coordinates
- Grab number
- Water depth
- Penetration depth
- Occurrence of any debris or refusal
- Sample depth

Upon retrieval, material collected in the grab sampler will be evaluated for acceptability according to the following criteria:

- Sampler is not overfilled
- Overlying water is present, indicating minimal leakage
- Overlying water is not excessively turbid, indicating minimal sample disturbance
- Sediment surface is relatively undisturbed, indicating minimal disturbance or winnowing
- Desired sediment penetration depth is attained

Following sediment sample acceptance, the overlying water will be carefully removed and the upper 11 cm of sediment will be collected in accordance with USEPA (2001) guidelines. Stainless steel spatulas and spoons will be used to transfer the sediment into a stainless steel bowl. A stainless steel ruler will be used to ensure that the sediment penetration depth of the sampler is adequate and that the correct sediment depth interval is removed. Sediment touching the sides of the grab sampler will not be sampled.

As sediment is removed from the sampler, the following physical characteristics will be noted in the field logbook:

- Sediment type
- Color
- Odor

- Other pertinent information such as the presence of debris, organic matter, or organisms

#### 3.5.1.1.1 Sample Processing – Sediment Grabs for Sediment/Porewater Analyses

Immediately following the collection of an acceptable surface sample, the sediment will be transferred into a stainless steel bowl and the contents will be homogenized. The homogenized material will be placed in sample containers. Subsamples collected for porewater analyses will be transferred to certified, pre-labeled, pre-cleaned 1-liter (L) polycarbonate centrifuge tubes. Subsamples collected for sediment chemistry will be transferred to certified, pre-labeled, pre-cleaned glass containers with PTFE-lined lids. Field measurements of redox potential (Eh) and pH of sediments will be measured and recorded. The porewater and sediment analyte lists are provided in Tables 6 and 7, respectively, and include the following, in addition to mercury and VOC (discussed later) and conventional sediment parameters:

- PAHs and phthalates
- PCB congeners
- DDT and isomers
- HCB
- HCBD
- Metals

All samples will be stored in a cooler on ice and shipped to Columbia Analytical Services (CAS) for analysis. CAS will be responsible for centrifuging the collected samples to separate porewater from the solids. Porewater will be filtered through a 0.45 µm nitro-cellulose filter for dissolved contaminant analyses using the methods and practical quantitation limits described in Table 5.

#### 3.5.1.2 Mercury

Because the chemical speciation of mercury is sensitive to changes in redox that occur between the sediment/water interface and deeper intervals (Bloom et al. 1999), the recommended program for establishing the methylation potential for mercury

and distribution coefficients for mercury and methyl mercury are more detailed than for the organic compounds. Sample locations for mercury sampling are the same as those provided for the organic compounds (Figure 11, Table 4). The following procedures are recommended for the analysis and evaluation of mercury speciation in porewater and bulk sediments. These procedures were developed during a comprehensive comparison of field methods for extracting porewater for low-level mercury analyses at the Lavaca Bay Superfund Site in Texas by industry, academic, analytical laboratory, and Anchor personnel (Cappellino and others, 1997).

The method involves the following:

- Sampling the sediment in the field using an acrylic core tube on a piston core
- Using a hydraulic extruder to obtain 2-cm interval samples over the top 20 cm of the core inside a glove box filled with nitrogen
- Centrifuging the sediment from the 2-cm intervals at the field locations as soon as practical inside a glove bag filled with nitrogen to prevent potential oxidation of mercury
- Field filtering the supernatant porewater through a 0.45  $\mu\text{m}$  nitro-cellulose filter under a “clean” hood (approximately 60 ml of porewater should be collected from each 2-cm interval)
- Field preservation of the porewater sample with mercury-free sulfuric acid
- Shipping the resultant porewater sample for each interval and sediment to CAS for analysis of total mercury, methyl mercury, sulfide, and dissolved organic carbon.

#### 3.5.1.3 VOC

The procedures described here are similar to the USEPA-approved methods used for porewater collection at the Rhone-Poulenc Superfund site located in Seattle, Washington in the Lower Duwamish Waterway (USEPA 2005) and the Portland Harbor Superfund Site Northwest Natural “Gasco” Early Action Site (Gasco) (Anchor 2006).

### 3.5.1.3.1 Porewater Collection and Processing

The proposed locations for porewater collection for VOC analyses are the same as those recommended for mercury and other organic compounds (Figure 11, Table 4). Porewater will be collected using push-point minipiezometers fabricated using a design similar to the USEPA-constructed minipiezometers used for porewater collection in the Lower Duwamish Waterway and employed previously by Anchor at Gasco. Based on previous discussions between Anchor and USEPA Region 10 personnel (i.e., Bruce Duncan and Doc Thompson) during the Gasco project, the minipiezometers are a very effective tool for collection of shallow subsurface in-situ porewater. The minipiezometers are essentially a mini well point constructed of a stainless-steel rod with a screened end at the tip. The USEPA design will be revised slightly to include a larger diameter probe with a heavier weight stainless-steel construction, approximately 8 cm screened interval with a smaller aperture size near the tip of the probe, and a base plate attachment that will sit at the mudline elevation to minimize short-circuiting from the overlying water column and provide vertical stability to the piezometer. Clean polyethylene tubing will be connected to the end (at the opposite end of the screened portion) of the minipiezometer and extended through the water column to the deck of the sampling vessel and into a peristaltic pump or similar type pumping device. The samples will be pumped directly into the sampling jars from the tubing. The VOC samples will not be filtered to minimize potential volatilization.

A stepwise procedure for the collection of the porewater samples is discussed below.

1. **Purging Volume Determination and Field Blank Collection** – Insert the polyethylene tubing through the water-tight stopper in the end of the decontaminated minipiezometer and push the tubing through the probe to the non-screened end of the minipiezometer. Calculate the approximate volume contained within the minipiezometer and full length of polyethylene tubing necessary to reach the sampling depth from the peristaltic pump. Fill the minipiezometer and full length of polyethylene tubing with deionized water. Pump one tube volume (calculated above)

of deionized water through the full length of the tube. Collect the deionized water directly into certified, pre-cleaned and pre-labeled sample jars for VOC analysis if a field blank is required. Refill the minipiezometer and full length of tubing with deionized water.

2. **Determine Sampling Depth** – Affix a decontaminated stainless-steel clamp to the appropriate location on the minipiezometer so that the clamp comes into contact with the baseplate where the screened interval of the probe will reach the desired sampling depth (i.e., bottom of screened interval is at 11 cm). This allows easy and accurate drive of the minipiezometer to the correct depth below the mudline.
3. **Sampling Location** – Manually drive the minipiezometer until the baseplate comes into contact with the sediment surface, indicating the screen has been placed at the desired sampling interval.
4. **Initial Purging** – Connect the tubing to a peristaltic pump or similar type pumping device and purge the minipiezometer using a low-flow pumping rate. Low-flow pumping rate will be maintained between approximately 80 to 100 milliliter (ml) per minute. Purge until the calculated purge volume (Step 1) is reached. Discard this waste volume (i.e., deionized water).
5. **Collect the Porewater Sample** – Maintaining a low-flow pumping rate (i.e., approximately 80 to 100 ml per minute), collect the sample volume for VOC directly into laboratory supplied certified, pre-cleaned, and pre-labeled sampling containers (40 ml VOA vials; 2 per sample). The sampling container will be free of all headspace and capped immediately to minimize the potential for volatilization loss.

Laboratory methods and analyses are detailed in Tables 6 and 7. Some modifications to the procedures may be made depending on site-specific conditions within Patrick Bayou.

## 4 MEASUREMENT, DATA ACQUISITION, AND REPORTING

### 4.1 Sediment and Water Related Data

#### 4.1.1 Field Quality Assurance/Quality Control (QA/QC)

##### 4.1.1.1 Field Quality Assurance Samples

Per the General RI Work Plan Quality Assurance Project Plan (QAPP; Anchor 2007), the following field QA/QC procedures for porewater and bulk sediment chemistry will be followed:

- Field duplicates will be sampled and submitted for analysis at a frequency of 5 percent of samples submitted for porewater and bulk sediment chemistry
- Field equipment rinsate/field blank samples for VOC analysis will be collected according to the procedures described in Table 11-1 of the RI Work Plan QAPP (Anchor 2007). Two sets of equipment rinsate/field blanks will be collected.
- Trip blanks will be included in each shipment of VOC samples to the laboratory. Trip blanks will be handled according to the procedures described in Table 11-1 of the RI Work Plan QAPP (Anchor 2007).
- Temperature indicators will be included in each container for shipment of porewater or bulk sediment chemistry to the laboratory.

##### 4.1.1.2 Performance Audits and Corrective Actions

Performance audits and corrective actions will be performed per the RI Work Plan QAPP (Section 16; Anchor 2007)

#### 4.1.2 Field Documentation and Sample Identification

Field sample logs and notebooks will be maintained for all samples collected during the field program. All sample field notebooks will have numbered pages. All data entries will be made using indelible-ink pens. Corrections will be made by drawing a single line through the error, writing in the correct information, then dating and initialing the change.

At a minimum, the following information will be included in the log for sediment cores and surface grabs:

1. The sample station number

2. Location of each sample station as determined by DGPS
3. Date and collection time of each sediment sample
4. Names of field supervisor and person(s) collecting and logging the sample
5. The mudline depth as measured by a lead line or fathometer, converted to a mudline elevation using the tide heights provided by either the nearest NOAA tide gage or surveyed tide gage
6. Observations made during sample collection including: weather conditions, complications, ship traffic, and other details associated with the sampling effort
7. Length and recovery for each sediment core or grab sample
8. Qualitative notation of apparent resistance of sediment column to coring/sampling, including notes on debris
9. Any deviation from the approved Work Plan

During sample processing, the following information should be recorded in the sample logsheet or field log:

1. Sample recovery (depth in feet of penetration and sample compaction)
2. Physical soil description in accordance with the Unified Soil Classification System (includes soil type, density/consistency of soil, and color)
3. Sediment redox potential (Eh) and pH
4. Odor (e.g., hydrogen sulfide, petroleum, etc.)
5. Vegetation
6. Debris
7. Biological activity (e.g., detritus, shells, tubes, bioturbation, or live or dead organisms)
8. Presence and depth (in feet) of the redox potential discontinuity layer
9. Presence of oil sheen
10. Any other distinguishing characteristics or features

#### *4.1.2.1 Sample Identification*

Sample identification will include depth interval information and will be performed as described below.

#### 4.1.2.1.1 Sediment Cores and Grabs

The identification scheme for sediment cores and grabs will be as described below. For example, for sample PB###-XX###-X:

- PB###-XX###-X: Each location will be identified by PB, to depict the project location (Patrick Bayou), and the station identifier associated with the channel station in hundreds of feet (e.g., PB100). Samples collected in the East Fork will be designated with EF.
- PB###-XX###-X: Individual samples at each location will be identified by the same alphanumeric identifier used to identify the stations, followed by a one digit numeric substation identifier, a two digit matrix identifier (i.e., SC = sediment core and SS = surface sediment grab, PW = sediment pore water), and a three digit number identifying the lower interval measurement (in cm) for that sample.
- PB###-XX###-X: An alphanumeric identifier indicating the sample type:
  - N – normal sample
  - D – field duplicate or homogenization split of the normal sample.

#### 4.1.3 Sample Handling and Transport

As described in the RI Work Plan Quality Assurance Project Plan (QAPP), components of sample custody procedures include the use of field logbooks, sample labels, custody seals, and chain-of-custody (COC) forms. Each person involved with sample handling will be trained in COC procedures before the start of the field program. The COC form will accompany the samples during shipment from the field to the laboratory.

#### 4.1.4 Field Custody

The following procedures will be used to document, establish, and maintain custody of field samples:

1. Sample labels will be completed for each sample with waterproof ink, making sure that the labels are legible and affixed firmly on the sample container.
2. All sample-related information will be recorded in the project logbook.
3. The field sampler will retain custody of the samples until they are transferred or properly dispatched.

4. To simplify the COC record and minimize potential problems, as few people as possible should handle the samples. For this reason, one individual from the field sampling team will be designated as the responsible individual for all sample transfer activities. This field investigator will be responsible for the care and custody of the samples until they are properly transferred to another person or facility.
5. A COC form will accompany all samples. This record documents the transfer of custody of samples from the field sampler to the laboratory. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record.
6. Samples will be properly packaged for shipment and sent to the appropriate laboratory for analysis with a separate signed COC form, enclosed in a plastic bag, and taped inside the cover of each sample box or cooler. The original record will accompany the shipment, and a copy will be retained by the Field Supervisor. When samples are relinquished to shipping companies for transport, the tracking number will be recorded on the COC form.
7. The COC must be signed when relinquished by field personnel and signed by the laboratory receiving the samples.
8. Custody seals will be used on the shipping containers when samples are shipped to the laboratory to inhibit sample tampering during transportation.

#### **4.1.5 Laboratory Sample Custody**

Each laboratory receiving samples for this project must comply with the laboratory sample custody requirements outlined in its Quality Assurance Plan (QAP). The laboratory will designate a sample custodian who will be responsible for maintaining custody of the samples and for maintaining all associated records documenting that custody. In addition, the laboratory will provide the following quality checks:

- The laboratory will check to see that there has been no tampering with the custody seals on the coolers.
- Upon receipt of the samples, the custodian will check the original COC and request-for-analysis documents and compare them with the labeled contents of each sample container for corrections and traceability. The sample custodian

will sign the COC and record the date and time received in the 'Received by Laboratory' box.

- The sample custodian also will assign a unique laboratory sample number to each sample.
- Cooler temperature will be checked and recorded.
- Care will be exercised to annotate any labeling or descriptive errors. If discrepancies occur in the documentation, the laboratory will immediately contact the sample tracking coordinator and Project Chemist as part of the corrective action process. A qualitative assessment of each sample container will be performed to note anomalies, such as broken or leaking bottles. This assessment will be recorded as part of the incoming COC procedure.

Samples will be stored in a secured area and at a temperature of  $4^{\circ} \pm 2^{\circ}\text{C}$ , if necessary, until analyses are to begin. Unless otherwise specified by the Project Manager, samples will be retained for a period of 60 days after the final report is released by the laboratory, after which they will be disposed in accordance with the laboratory Standard Operating Procedures (SOP) for waste disposal.

#### **4.1.6 Sample Packing and Shipping**

During the field efforts, the Anchor Project Chemist will notify the appropriate laboratories about sample shipments. The Anchor Field Team Leader will fax copies of the COC to the Laboratory Project Manager for each day of sampling.

Hard plastic ice chests or coolers with similar durability will be used for shipping samples. The coolers must be able to withstand a 4-foot drop onto solid concrete in the position most likely to cause damage. Samples will be double-bagged in Ziploc bags and grouped by sample set. Styrofoam or bubble wrap will be used as packing material to protect the samples from leakage during shipment. A volume of ice approximately equal to the sample volume should be present in each cooler. Blue ice will not be used. After packing is complete, the cooler will be taped securely, with custody seals affixed across the top and bottom joints. In addition, these procedures will be followed when packing coolers of samples for shipping:

1. Include absorbent material in the cooler to absorb any ice melt

2. Record the airbill on each COC
3. List the appropriate contact person on the COC
4. Use custody seals on the cooler

Samples will be shipped priority overnight FedEx or transported by courier (or equivalent) to the laboratory.

#### **4.1.7 Investigation Derived Waste Handling and Tracking**

This section provides a waste management plan for handling investigation derived waste (IDW) associated with initial RIs at the Site.

IDW for this Work Package is expected to consist of:

- Excess sediment generated during sampling (cores and slurries)
- Excess surface water and porewater during sampling
- Personal protective equipment (PPE) and other solid waste
- Decontamination and rinse water

##### **4.1.7.1 Sediment**

Generation of some excess sample material is anticipated during collection of cores. Whenever possible, core material will be returned to the environment by returning the sediment back to the collection site (Patrick Bayou).

Field sampling conditions (weather conditions or other unanticipated events, such as leaks or spills at adjacent industrial locations) may preclude safe disposal of excess material at the time of sampling. If needed, excess sediments and slurries will be retained and stored in lined 10-gallon buckets for later return to the environment at the Site.

If needed, sediments and slurries will be retained and stored in lined 50-gallon drum(s) for later disposal at an approved solid waste handling facility. Drums will be clearly marked as to contents. A log of collection dates and times, plus approximate volume of each sample, will be maintained to facilitate off-site disposal of the material as either non-hazardous or hazardous dredge spoil material.

#### **4.1.7.2 Porewater**

Generation of excess porewater and surface water is possible during collection of cores for depth-specific characterization and profiles of COPCs within the Site. During the collection of sediments, whenever possible, excess aqueous material will be returned directly to the Site. Porewater will be returned to the environment by retaining it during sampling in a tray or bucket, and then dumping it in to the waters surrounding the sample processing location. Dilution of COPCs by ambient waters should be sufficient to achieve non-hazardous levels or no appreciable increase in ambient COPCs.

If needed, excess porewater may be retained and stored in lined 10-gallon buckets for later return to the environment at the Site.

#### **4.1.7.3 Decontamination and Rinse Water**

Decontamination and rinse water will be retained in lined 10-gallon buckets, and disposed of via the municipal sewer system. Dilution of COPCs by flushing with tap water and the additional dilution of COPCs by other sources of flow in the municipal sewer system should be sufficient to achieve non-hazardous levels or no appreciable increase in ambient COPCs. If decontamination occurs within a private facility (e.g., Shell, OxyVinyls, or Lubrizol), IDW tracking and disposal procedures will be followed.

#### **4.1.7.4 PPE and Solid Waste**

PPE and solid waste will be decontaminated to the extent possible and disposed as municipal waste.

## **4.2 Data Management and QA/QC**

Document and record management is critical to project performance. The procedures in this section will ensure that data (including raw and processed data) reporting is prepared in a timely fashion. The data will be reviewed, approved, disseminated, and maintained, as required in this section and in accordance with the Site Data Management Plan (DMP) and QAPP, submitted as part of the RI Work Plan (Anchor 2007). The following sections define

data management and QA/QC procedures for field collected data not addressed in the DMP and QAPP.

#### **4.2.1 Field Service Event Records**

During each field servicing event of the accretion stations or sediment traps, written field notes will be taken noting the date, time, location, instrument, and sample numbers for each event. Any problems or issues that may occur in the field will be noted as well. Field procedures and data processing for these activities are described in Appendix B.

Subsequent to each field servicing event, the Anchor Field Team Leader will make one copy of all field notes and other pertinent records. A brief field servicing event report will be generated that describes any logistical problems encountered in the field and any potential impacts to the data. This report will be provided to the Anchor Project Manager and a copy placed in the project file.

#### **4.2.2 Data Validation and Review**

Data validation will be conducted in two phases, each phase performed by a different person. Phase I will be performed by the individual responsible for field collection of data (field team leader); Phase II will be executed by a designated data management QA/QC officer. General responsibilities and procedures are described below.

##### **4.2.2.1 Phase 1 – Initial Data Validation**

Phase 1 will be performed by the field team leader or designee during the initial data entry and verification. Once appropriate information from the calibration field logs are loaded into the appropriate spreadsheet or database, the QA/QC procedures described below for the current record will be performed.

Once the current datum record has been validated, it will be imported into the project database and appended to the station record. The following QA/QC procedures will be performed for the station record:

- The data will be checked for normal transition between the last datum record (previously collected data) and the present datum record.

- A Phase 1 data validation report package will be prepared that will include:  
(a) QA/QC data checklist; (b) electronic data files (current datum record and updated project database); and (c) field trip report.

#### *4.2.2.2 Phase 2 – Data Validation Review*

The data management QA/QC officer will review the initial data validation report package(s) provided by the Anchor Field Team Leader. The following QA/QC procedures will be performed by the QA/QC officer:

- Completion of a data validation checklist

The data management QA/QC officer will be responsible for maintaining the reviewed data validation reports, consisting of the signed checklist and initial data validation report.

## **5 LABORATORY ANALYTICAL METHODS, QUALITY CONTROL, AND MEASUREMENT QUALITY OBJECTIVES**

Analytical methods and the associated method reporting limits for sediment samples collected as part of this Work Package are listed in Table 5 and 6. For comparison purposes, sediment quality guideline values (Effect Range- Median [ERM] and Total Equivalency Levels [TEL]) from the National Oceanic and Atmospheric Administration (NOAA) Quick Reference Table (SQuiRT; Buchanan 1999) are included for sediment. For porewater, Texas Commission on Environmental Quality (TCEQ) Surface Water Ecological Benchmarks (Marine; TCEQ 2006), National Ambient Water Quality Criteria (Saltwater CCC; USEPA 2006), or Final Chronic Values (PAH only; USEPA 2003) were included for comparison.

A summary of laboratory quality control samples and frequency of analysis for this Work Package are listed in Table 7.

Laboratory measurement quality objectives for precision, accuracy, and completeness of sediment chemistry analysis for this Work Package are listed in Table 8.

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## TABLES

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**Table 1**  
**Summary of Parameters Measured in Sedflume Testing**

	Definition	Units	Detection Limit	Int. Consistency
Wet Bulk Density, $\rho_b$ (wet/dry weight)	$\rho_b = \frac{\rho_w \rho_b}{\rho_w + (\rho_b - \rho_w)W}$	g/cm <sup>3</sup>	Same as water content	$\rho_w < \rho_b < 2.6\rho_w$
Grain Size	Volume weighted distribution including median and mean size	μm	0.1 μm	
Water Content	$W = \frac{M_w - M_d}{M_w}$	none	0.1g in sample weight ranging from 10 to 50 g	$0 < W < 1$
Erosion Rate	$E = \Delta z/T$	cm/s	$\Delta z > 0.5\text{mm}$ $T > 15\text{s}$	

Notes:

$M_w$  = wet weight of sample

$M_d$  = dry weight of sample

$\Delta z$  = amount of sediment eroded

T = time

$\rho_w$  = density of water

All essential bulk properties will be measured from the same core.

**Table 2a**  
**Summary of Sediment Accretion and Upstream Sediment Trap Study Designs**

Station ID	Station Coordinates <sup>a, b</sup>		Sediment Accretion	Sediment Trap
	Northing	Easting		
PB003	13836425.37	3202339.46	X	
PB014	13826344.50	3201533.38	X	
PB018	13835837.70	3201070.29	X	
PB023	13835498.23	3201097.95	X	
PB035 <sup>c</sup>	13834114.31	3201378.46	X	
PB048	13832959.40	3201502.80	X	
PB057	13832096.55	3201519.36	X	
EF001	13831226.21	3201612.72		X
PB062 <sup>c</sup>	13831338.02	3201542.97	X	
PB077	13830368.06	3200780.25		X

a Station Coordinates are State Plane coordinates based on North American Datum (NAD) 83 for Texas, South Central.

b Locations are approximate and may be adjusted in the field.



**Table 2b**  
**Summary of Sediment Trap Sample Analyses**

Station ID	Sample ID	Station Coordinates <sup>a, b</sup>		Metals <sup>d</sup> , Mercury	PCB Congeners <sup>f</sup>	SVOC <sup>d,e</sup>	Pesticides <sup>f</sup>
		Northing	Easting				
EF001	EF001-1ST-N	13831226.21	3201612.72	X	X	X	X
PB077	PB077-1ST-N	13830368.06	3200780.25	X	X	X	X

Notes:

- a Station Coordinates are State Plane coordinates based on North American Datum (NAD) 83 for Texas, South Central.
- b Locations are approximate and may be changed depending on field conditions encountered at the proposed location.
- c Northing/Easting approximate.
- d Metals include arsenic, barium cadmium, chromium, copper, lead, nickel, selenium, silver, and zinc
- e Includes low- and high-molecular weight PAHs and phthalates on Table 6; alkylated-substituted PAH homologs are not included; see Table 6 for complete list of low- and high-molecular weight PAH.
- f See Table 6 for complete list of PCB congeners and pesticides included in sample design

**Table 3**  
**Summary of Geotechnical Evaluation Sampling Study Design**

Station ID	Station Coordinates <sup>a, b</sup>		SICT	VST	TOC	Bulk Density <sup>c</sup>	Physical Tests <sup>d</sup>
	Northing	Easting					
Geotechnical Evaluation							
PB006A	13836290.09	3202096.636		X	X	X	X
PB009	13836190.69	3201850.92	X	X	X	X	X
PB016	13836120.76	3201194.62		X	X	X	X
PB022	13835498.23	3201097.95	X	X	X	X	X
PB023	13835323.99	3201282.606		X	X	X	X
PB030	13834707.34	3201335.33		X	X	X	X
PB036	13834114.31	3201378.46	X	X	X	X	X
PB042	13833551.36	3201354.53		X	X	X	X
PB046	13833141.31	3201479.405		X	X	X	X
PB048	13832959.40	3201502.80	X	X	X	X	X
PB053	13832461.46	3201416.787		X	X	X	X
PB059	13831853.18	3201577.804		X	X	X	X
PB063	13831338.02	3201542.97	X	X	X	X	X
PB073	13830742.28	3201037.34		X	X	X	X
PB077	13830368.06	3200780.25		X	X	X	X

Notes:

a - Station Coordinates are State Plane coordinates based on North American Datum (NAD) 83 for Texas, South Central.

b - Locations are approximate and may be adjusted in the field.

c - Bulk density determination includes wet weight, percent water content, and dry weight

d - Planned physical tests include grain size (ASTM D 422), Atterberg limits (ASTM D 4318), specific gravity (ASTM D 854), consolidated undrained triaxial compression (ASTM D 4767), and oedometer consolidation (ASTM D 2435).

SICT - Seepage Induced Consolidation Test

VST - Vane Shear Test; three depths planned for each location

TOC - Total Organic Carbon

**Table 4**  
**Summary of Porewater Sampling Design**

Station ID	Sample ID	Depth Interval (cm) <sup>e</sup>	Station Coordinates <sup>a, b</sup>		Mercury	Methyl Mercury	Metals <sup>c</sup>	PCB Congeners <sup>c</sup>	SVOC <sup>d</sup>	HCB/HCBD	Total DDT <sup>c</sup>	VOC <sup>c</sup>
			Northing	Easting								
PB006A	PB006A-1PW011-N	0-11	13836290.09	3202096.636			X	X	X	X	X	X
PB006A	PB006A-2PW002-N	0-2	13836290.09	3202096.636	X	X						
PB006A	PB006A-2PW004-N	2-4	13836290.09	3202096.636	X	X						
PB006A	PB006A-2PW006-N	4-6	13836290.09	3202096.636	X	X						
PB006A	PB006A-2PW008-N	6-8	13836290.09	3202096.636	X	X						
PB006A	PB006A-2PW010-N	8-10	13836290.09	3202096.636	X	X						
PB006A	PB006A-2PW012-N	10-12	13836290.09	3202096.636	X	X						
PB006A	PB006A-2PW014-N	12-14	13836290.09	3202096.636	X	X						
PB006A	PB006A-2PW016-N	14-16	13836290.09	3202096.636	X	X						
PB006A	PB006A-2PW018-N	16-18	13836290.09	3202096.636	X	X						
PB006A	PB006A-2PW020-N	18-20	13836290.09	3202096.636	X	X						
PB006B	PB006B-1PW011-N	0-11	13836138.02	3202141.363			X	X	X	X	X	X
PB006B	PB006B-2PW002-N	0-2	13836138.02	3202141.363	X	X						
PB006B	PB006B-2PW004-N	2-4	13836138.02	3202141.363	X	X						
PB006B	PB006B-2PW006-N	4-6	13836138.02	3202141.363	X	X						
PB006B	PB006B-2PW008-N	6-8	13836138.02	3202141.363	X	X						
PB006B	PB006B-2PW010-N	8-10	13836138.02	3202141.363	X	X						
PB006B	PB006B-2PW012-N	10-12	13836138.02	3202141.363	X	X						
PB006B	PB006B-2PW014-N	12-14	13836138.02	3202141.363	X	X						
PB006B	PB006B-2PW016-N	14-16	13836138.02	3202141.363	X	X						
PB006B	PB006B-2PW018-N	16-18	13836138.02	3202141.363	X	X						
PB006B	PB006B-2PW020-N	18-20	13836138.02	3202141.363	X	X						
PB023	PB023-1PW011-N	0-11	13835323.99	3201282.606			X	X	X	X	X	X
PB023	PB023-2PW002-N	0-2	13835323.99	3201282.606	X	X						
PB023	PB023-2PW004-N	2-4	13835323.99	3201282.606	X	X						
PB023	PB023-2PW006-N	4-6	13835323.99	3201282.606	X	X						
PB023	PB023-2PW008-N	6-8	13835323.99	3201282.606	X	X						
PB023	PB023-2PW010-N	8-10	13835323.99	3201282.606	X	X						
PB023	PB023-2PW012-N	10-12	13835323.99	3201282.606	X	X						
PB023	PB023-2PW014-N	12-14	13835323.99	3201282.606	X	X						
PB023	PB023-2PW016-N	14-16	13835323.99	3201282.606	X	X						

**Table 4**  
**Summary of Porewater Sampling Design**

Station ID	Sample ID	Depth Interval (cm) <sup>e</sup>	Station Coordinates <sup>a, b</sup>		Mercury	Methyl Mercury	Metals <sup>c</sup>	PCB Congeners <sup>c</sup>	SVOC <sup>d</sup>	HCB/HCBD	Total DDT <sup>c</sup>	VOC <sup>c</sup>
			Northing	Easting								
PB023	PB023-2PW018-N	16-18	13835323.99	3201282.606	X	X						
PB023	PB023-2PW020-N	18-20	13835323.99	3201282.606	X	X						
PB024	PB024-1PW011-N	0-11	13835234.53	3201157.371			X	X	X	X	X	X
PB024	PB024-2PW002-N	0-2	13835234.53	3201157.371	X	X						
PB024	PB024-2PW004-N	2-4	13835234.53	3201157.371	X	X						
PB024	PB024-2PW006-N	4-6	13835234.53	3201157.371	X	X						
PB024	PB024-2PW008-N	6-8	13835234.53	3201157.371	X	X						
PB024	PB024-2PW010-N	8-10	13835234.53	3201157.371	X	X						
PB024	PB024-2PW012-N	10-12	13835234.53	3201157.371	X	X						
PB024	PB024-2PW014-N	12-14	13835234.53	3201157.371	X	X						
PB024	PB024-2PW016-N	14-16	13835234.53	3201157.371	X	X						
PB024	PB024-2PW018-N	16-18	13835234.53	3201157.371	X	X						
PB024	PB024-2PW020-N	18-20	13835234.53	3201157.371	X	X						
PB036	PB036-1PW011-N	0-11	13834114.31	3201378.46			X	X	X	X	X	X
PB036	PB036-2PW002-N	0-2	13834114.31	3201378.46	X	X						
PB036	PB036-2PW004-N	2-4	13834114.31	3201378.46	X	X						
PB036	PB036-2PW006-N	4-6	13834114.31	3201378.46	X	X						
PB036	PB036-2PW008-N	6-8	13834114.31	3201378.46	X	X						
PB036	PB036-2PW010-N	8-10	13834114.31	3201378.46	X	X						
PB036	PB036-2PW012-N	10-12	13834114.31	3201378.46	X	X						
PB036	PB036-2PW014-N	12-14	13834114.31	3201378.46	X	X						
PB036	PB036-2PW016-N	14-16	13834114.31	3201378.46	X	X						
PB036	PB036-2PW018-N	16-18	13834114.31	3201378.46	X	X						
PB036	PB036-2PW020-N	18-20	13834114.31	3201378.46	X	X						
PB044	PB044-1PW011-N	0-11	13833311.28	3201550.968			X	X	X	X	X	X
PB044	PB044-2PW002-N	0-2	13833311.28	3201550.968	X	X						
PB044	PB044-2PW004-N	2-4	13833311.28	3201550.968	X	X						
PB044	PB044-2PW006-N	4-6	13833311.28	3201550.968	X	X						
PB044	PB044-2PW008-N	6-8	13833311.28	3201550.968	X	X						
PB044	PB044-2PW010-N	8-10	13833311.28	3201550.968	X	X						
PB044	PB044-2PW012-N	10-12	13833311.28	3201550.968	X	X						

**Table 4**  
**Summary of Porewater Sampling Design**

Station ID	Sample ID	Depth Interval (cm) <sup>e</sup>	Station Coordinates <sup>a, b</sup>		Mercury	Methyl Mercury	Metals <sup>c</sup>	PCB Congeners <sup>c</sup>	SVOC <sup>d</sup>	HCB/HCBD	Total DDT <sup>c</sup>	VOC <sup>c</sup>
			Northing	Easting								
PB044	PB044-2PW014-N	12-14	13833311.28	3201550.968	X	X						
PB044	PB044-2PW016-N	14-16	13833311.28	3201550.968	X	X						
PB044	PB044-2PW018-N	16-18	13833311.28	3201550.968	X	X						
PB044	PB044-2PW020-N	18-20	13833311.28	3201550.968	X	X						
PB046	PB046-1PW011-N	0-11	13833141.31	3201479.405			X	X	X	X	X	X
PB046	PB046-2PW002-N	0-2	13833141.31	3201479.405	X	X						
PB046	PB046-2PW004-N	2-4	13833141.31	3201479.405	X	X						
PB046	PB046-2PW006-N	4-6	13833141.31	3201479.405	X	X						
PB046	PB046-2PW008-N	6-8	13833141.31	3201479.405	X	X						
PB046	PB046-2PW010-N	8-10	13833141.31	3201479.405	X	X						
PB046	PB046-2PW012-N	10-12	13833141.31	3201479.405	X	X						
PB046	PB046-2PW014-N	12-14	13833141.31	3201479.405	X	X						
PB046	PB046-2PW016-N	14-16	13833141.31	3201479.405	X	X						
PB046	PB046-2PW018-N	16-18	13833141.31	3201479.405	X	X						
PB046	PB046-2PW020-N	18-20	13833141.31	3201479.405	X	X						
PB052	PB052-1PW011-N	0-11	13832541.97	3201282.606			X	X	X	X	X	X
PB052	PB052-2PW002-N	0-2	13832541.97	3201282.606	X	X						
PB052	PB052-2PW004-N	2-4	13832541.97	3201282.606	X	X						
PB052	PB052-2PW006-N	4-6	13832541.97	3201282.606	X	X						
PB052	PB052-2PW008-N	6-8	13832541.97	3201282.606	X	X						
PB052	PB052-2PW010-N	8-10	13832541.97	3201282.606	X	X						
PB052	PB052-2PW012-N	10-12	13832541.97	3201282.606	X	X						
PB052	PB052-2PW014-N	12-14	13832541.97	3201282.606	X	X						
PB052	PB052-2PW016-N	14-16	13832541.97	3201282.606	X	X						
PB052	PB052-2PW018-N	16-18	13832541.97	3201282.606	X	X						
PB052	PB052-2PW020-N	18-20	13832541.97	3201282.606	X	X						
PB053	PB053-1PW011-N	0-11	13832461.46	3201416.787			X	X	X	X	X	X
PB053	PB053-2PW002-N	0-2	13832461.46	3201416.787	X	X						
PB053	PB053-2PW004-N	2-4	13832461.46	3201416.787	X	X						
PB053	PB053-2PW006-N	4-6	13832461.46	3201416.787	X	X						
PB053	PB053-2PW008-N	6-8	13832461.46	3201416.787	X	X						

**Table 4**  
**Summary of Porewater Sampling Design**

Station ID	Sample ID	Depth Interval (cm) <sup>e</sup>	Station Coordinates <sup>a, b</sup>		Mercury	Methyl Mercury	Metals <sup>c</sup>	PCB Congeners <sup>c</sup>	SVOC <sup>d</sup>	HCB/HCBD	Total DDT <sup>c</sup>	VOC <sup>c</sup>
			Northing	Easting								
PB053	PB053-2PW010-N	8-10	13832461.46	3201416.787	X	X						
PB053	PB053-2PW012-N	10-12	13832461.46	3201416.787	X	X						
PB053	PB053-2PW014-N	12-14	13832461.46	3201416.787	X	X						
PB053	PB053-2PW016-N	14-16	13832461.46	3201416.787	X	X						
PB053	PB053-2PW018-N	16-18	13832461.46	3201416.787	X	X						
PB053	PB053-2PW020-N	18-20	13832461.46	3201416.787	X	X						
PB059	PB059-1PW011-N	0-11	13831853.18	3201577.804			X	X	X	X	X	X
PB059	PB059-2PW002-N	0-2	13831853.18	3201577.804	X	X						
PB059	PB059-2PW004-N	2-4	13831853.18	3201577.804	X	X						
PB059	PB059-2PW006-N	4-6	13831853.18	3201577.804	X	X						
PB059	PB059-2PW008-N	6-8	13831853.18	3201577.804	X	X						
PB059	PB059-2PW010-N	8-10	13831853.18	3201577.804	X	X						
PB059	PB059-2PW012-N	10-12	13831853.18	3201577.804	X	X						
PB059	PB059-2PW014-N	12-14	13831853.18	3201577.804	X	X						
PB059	PB059-2PW016-N	14-16	13831853.18	3201577.804	X	X						
PB059	PB059-2PW018-N	16-18	13831853.18	3201577.804	X	X						
PB059	PB059-2PW020-N	18-20	13831853.18	3201577.804	X	X						

Notes:

- a Station Coordinates are State Plane coordinates based on North American Datum (NAD) 83 for Texas, South Central
- b Station coordinates are approximate and may be adjusted on location to accommodate field conditions.
- c See Table 5 and 6 for complete list of analytes/congeners included in analyses for porewater and sediment, respectively
- d Includes low-, high-molecular weight PAH and alkyl substituted homologs and phthalates; see Table 5 and 6 for complete list of PAH analytes for porewater and sediment, respectively
- e Specific station and interval may be changed in the field to best represent site conditions

**Table 5**  
**Parameters for Analysis, Methods, and Practical Quantitation Limits for Porewater Samples**

Chemical Parameter	Analytical Method	Practical Quantitation Limits	MDL	MRL	Water Quality Criteria	WQC Source
<b>Porewater Analytes</b>						
<b>Dissolved Constituents (mg/L)</b>						
Ammonia	350.1	0.05	0.02	0.05	variable1	NRWQC
Total Organic Carbon (TOC)	415.1	0.10	0.03	0.10	--	NA
Dissolved Organic Carbon (DOC)	415.1	0.10	0.03	0.10	--	NA
Sulfide	EPA 9030	0.1	0.05	0.1	0.002	TCEQ 2006
<b>Metals (mg/L)</b>						
Mercury	EPA 163 1/ CAS-SOP	0.001	0.00006	0.0	0.0011	TCEQ 2006
Methyl mercury	EPA 1630 / CAS-SOP	0.1	0.04	0.1	0.00094	NRWQC
Arsenic, dissolved	EPA 200.8 - ICP/MS	0.5	0.2	0.5	0.078	TCEQ 2006
Barium, dissolved	EPA 200.8 - ICP/MS	0.5	0.3	0.5	25	TCEQ 2006
Cadmium, dissolved	EPA 200.8 - ICP/MS	0.02	0.007	0.02	0.01	TCEQ 2006
Copper, dissolved	EPA 200.8 - ICP/MS	0.1	0.02	0.1	0.0036	TCEQ 2006
Chromium, dissolved (III + VI)	EPA 200.8 - ICP/MS	0.2	0.2	0.2	0.103	TCEQ 2006
Lead, dissolved	EPA 200.8 - ICP/MS	0.02	0.02	0.02	0.0053	TCEQ 2006
Nickel, dissolved	EPA 200.8 - ICP/MS	0.2	0.04	0.2	0.0131	TCEQ 2006
Selenium, dissolved	7742	1	0.3	1	0.136	TCEQ 2006
Silver, dissolved	EPA 200.8 - ICP/MS	0.02	0.008	0.02	0.0002	TCEQ 2006
Zinc, dissolved	EPA 200.8 - ICP/MS	0.5	0.2	500	0.0842	TCEQ 2006
<b>Aromatic Hydrocarbons (µg/L)</b>						
<b>Low Molecular Weight PAH</b>						
Naphthalene	8270C/SIM	20	0.003	0.02	193.5	USEPA 2003
Acenaphthalene	8270C/SIM	20	0.002	0.02	306.9	USEPA 2003
Acenaphthene	8270C/SIM	20	0.002	0.02	55.85	USEPA 2003
Fluorene	8270C/SIM	20	0.003	0.02	39.3	USEPA 2003
Phenanthrene	8270C/SIM	20	0.003	0.02	19.13	USEPA 2003
Anthracene	8270C/SIM	20	0.001	0.02	20.73	USEPA 2003
2-Methylnaphthalene	8270C/SIM	20	0.002	0.02	72.16	USEPA 2003
1-Methylnaphthalene	8270C/SIM	20	0.002	0.02	75.37	USEPA 2003
<b>High Molecular Weight PAH</b>						
Fluoranthene	8270C/SIM	20	0.002	0.02	2.96	USEPA 2003
Pyrene	8270C/SIM	20	0.002	0.02	10.11	USEPA 2003
Benz(a)anthracene	8270C/SIM	20	0.001	0.02	2.227	USEPA 2003
Chrysene	8270C/SIM	20	0.001	0.02	2.042	USEPA 2003
Benzo(k)fluoranthene	8270C/SIM	20	0.001	0.02	0.6415	USEPA 2003
Benzo(a)pyrene	8270C/SIM	20	0.002	0.02	0.9573	USEPA 2003
Benzo(e)pyrene	8270C/SIM	20	0.002	0.02	0.9008	USEPA 2003
Indeno(1,2,3-cd) pyrene	8270C/SIM	20	0.002	0.02	0.275	USEPA 2003
Benzo(b)fluoranthene	8270C/SIM	20	0.002	0.02	0.6774	USEPA 2003
Dibenz(a,h)anthracene	8270C/SIM	20	0.001	0.02	0.2825	USEPA 2003
Benzo(g,h,i)perylene	8270C/SIM	20	0.003	0.02	0.4391	USEPA 2003
Perylene	8270C/SIM	20	0.001	0.02	0.9008	USEPA 2003
<b>Alkyl-substituted PAH homologs</b>						
C1-Naphthalenes	8270C/SIM	0.02	0.02	0.02	81.69	USEPA 2003
C1-Chrysenes	8270C/SIM	0.02	0.02	0.02	0.8557	USEPA 2003
C1-Fluoranthenes/Pyrenes	8270C/SIM	0.02	0.02	0.02	4.887	USEPA 2003
C1-Fluorenes	8270C/SIM	0.02	0.02	0.02	13.99	USEPA 2003

**Table 5**  
**Parameters for Analysis, Methods, and Practical Quantitation Limits for Porewater Samples**

Chemical Parameter	Analytical Method	Practical Quantitation Limits	MDL	MRL	Water Quality Criteria	WQC Source
C1-Phenanthrenes/Anthracenes	8270C/SIM	0.02	0.02	0.02	7.436	USEPA 2003
C2-Chrysenes	8270C/SIM	0.02	0.02	0.02	0.4827	USEPA 2003
C2-Fluorenes	8270C/SIM	0.02	0.02	0.02	5.305	USEPA 2003
C2-Naphthalenes	8270C/SIM	0.02	0.02	0.02	30.24	USEPA 2003
C2-Phenanthrenes/Anthracenes	8270C/SIM	0.02	0.02	0.02	3.199	USEPA 2003
C3-Chrysenes	8270C/SIM	0.02	0.02	0.02	0.1675	USEPA 2003
C3-Fluorenes	8270C/SIM	0.02	0.02	0.02	1.916	USEPA 2003
C3-Naphthalenes	8270C/SIM	0.02	0.02	0.02	11.1	USEPA 2003
C3-Phenanthrenes/Anthracenes	8270C/SIM	0.02	0.02	0.02	1.256	USEPA 2003
C4-Chrysenes	8270C/SIM	0.02	0.02	0.02	0.07062	USEPA 2003
C4-Naphthalenes	8270C/SIM	0.02	0.02	0.02	4.048	USEPA 2003
C4-Phenanthrenes/Anthracenes	8270C/SIM	0.02	0.02	0.02	0.5594	USEPA 2003
<b>Misc. Semivolatile Organics (µg/L)</b>						
Hexachlorobenzene	8081A	20	0.0006	0.01	0.0003	NRWQC
Hexachlorobutadiene	8081A	20	0.001	0.01	0.32	TCEQ 2006
bis(2-Ethylhexyl)phthalate	LL-8270	2	0.27	2	300	TCEQ 2006
Butylbenzylphthalate	LL-8270	0.2	0.03	0.2	147	TCEQ 2006
Diethylphthalate	LL-8270	0.2	0.03	0.2	442	TCEQ 2006
Dimethylphthalate	LL-8270	0.2	0.01	0.2	580	TCEQ 2006
Di-n-butylphthalate	LL-8270	0.2	0.03	0.2	5	TCEQ 2006
Di-n-octylphthalate	LL-8270	0.2	0.03	0.2	22	TCEQ 2006
<b>Volatile Organics (ug/l)</b>						
1,1,1,2-Tetrachloroethane	8260B	0.5	0.111	0.5	--	--
1,1,1-Trichloroethane (TCA)	8260B	0.5	0.113	0.5	1560	TCEQ 2006
1,1,2,2-Tetrachloroethane	8260B	0.5	0.138	0.5	451	TCEQ 2006
1,1,2-Trichloroethane	8260B	0.5	0.0992	0.5	275	TCEQ 2006
1,1-Dichloroethane	8260B	0.5	0.0906	0.5	2570	TCEQ 2006
1,1-Dichloroethene	8260B	0.5	0.119	0.5	12500	TCEQ 2006
1,1-Dichloropropene	8260B	0.5	0.128	0.5	--	--
1,2,3-Trichlorobenzene	8260B	2	0.326	2	--	--
1,2,3-Trichloropropane	8260B	0.5	0.213	0.5	--	--
1,2,4-Trichlorobenzene	8260B	2	0.218	2	22	TCEQ 2006
1,2,4-Trimethylbenzene	8260B	2	0.141	2	217	TCEQ 2006
1,2-Dibromo-3-chloropropane	8260B	2	0.991	2	--	--
1,2-Dibromoethane (EDB)	8260B	2	0.073	2	--	--
1,2-Dichlorobenzene	8260B	0.5	0.088	0.5	99	TCEQ 2006
1,2-Dichloroethane (EDC)	8260B	0.5	0.114	0.5	5650	TCEQ 2006
1,2-Dichloropropane	8260B	0.5	0.124	0.5	2400	TCEQ 2006
1,3,5-Trimethylbenzene	8260B	2	0.121	2	71	TCEQ 2006
1,3-Dichlorobenzene	8260B	0.5	0.102	0.5	142	TCEQ 2006
1,3-Dichloropropane	8260B	0.5	0.0759	0.5	--	--
1,4-Dichlorobenzene	8260B	0.5	0.098	0.5	99	TCEQ 2006
1,4-Dichlorobenzene-d4	8260B	Surg	Surg	Surg	--	--
2,2-Dichloropropane	8260B	0.5	0.174	0.5	--	--
2-Butanone (MEK)	8260B	20	1.9	20	42400	TCEQ 2006
2-Chlorotoluene	8260B	2	0.111	2	--	--
2-Hexanone	8260B	20	3.96	20	6130	TCEQ 2006

**Table 5**  
**Parameters for Analysis, Methods, and Practical Quantitation Limits for Porewater Samples**

Chemical Parameter	Analytical Method	Practical Quantitation Limits	MDL	MRL	Water Quality Criteria	WQC Source
4-Bromofluorobenzene	8260B	2	0.104	2	--	--
4-Chlorotoluene	8260B	2	0.128	2	--	--
4-Isopropyltoluene	8260B	20	1.8	20	--	--
4-Methyl-2-pentanone (MIBK)	8260B	20	4.08	20	61500	TCEQ 2006
Acetone	8260B	0.5	0.105	0.5	282000	TCEQ 2006
Benzene	8260B	2	0.172	2	109	TCEQ 2006
Bromobenzene	8260B	0.5	0.126	0.5	--	--
Bromochloromethane	8260B	0.5	0.0847	0.5	--	--
Bromodichloromethane	8260B	0.5	0.279	0.5	2160	TCEQ 2006
Bromoform	8260B	0.5	0.217	0.5	1220	TCEQ 2006
Bromomethane	8260B	0.5	0.159	0.5	600	TCEQ 2006
Carbon Disulfide	8260B	0.5	0.128	0.5	105	TCEQ 2006
Carbon Tetrachloride	8260B	0.5	0.0933	0.5	1500	TCEQ 2006
Chlorobenzene	8260B	0.5	0.226	0.5	105	TCEQ 2006
Chloroethane	8260B	0.5	0.0958	0.5	--	--
Chloroform	8260B	0.5	0.136	0.5	4100	TCEQ 2006
Chloromethane	8260B	0.5	0.136	0.5	13500	TCEQ 2006
cis-1,2-Dichloroethene	8260B	0.5	0.116	0.5	680	TCEQ 2006
cis-1,3-Dichloropropene	8260B	0.5	0.085	0.5	40	TCEQ 2006
Dibromochloromethane	8260B	0.5	0.0817	0.5	--	--
Dibromofluoromethane	8260B	0.5	0.1	0.5	--	--
Dibromomethane	8260B	0.5	0.166	0.5	--	--
Dichlorodifluoromethane	8260B	0.5	0.4	0.5	--	--
Ethylbenzene	8260B	0.5	0.13	0.5	--	--
Fluorobenzene	8260B	Surg	Surg	Surg	249	TCEQ 2006
Hexachlorobutadiene	8260B	2	0.28	2	0.32	TCEQ 2006
Isopropylbenzene	8260B	2	0.068	2	255	TCEQ 2006
m,p-Xylenes	8260B	0.5	0.219	0.5	850	TCEQ 2006
Methylene Chloride	8260B	2	0.193	2	5420	TCEQ 2006
Naphthalene	8260B	2	0.285	2	125	TCEQ 2006
n-Butylbenzene	8260B	2	0.221	2	36	TCEQ 2006
n-Propylbenzene	8260B	2	0.098	2	64	TCEQ 2006
o-Xylene	8260B	0.5	0.0785	0.5	850	TCEQ 2006
sec-Butylbenzene	8260B	2	0.127	2	41	TCEQ 2006
Styrene	8260B	0.5	0.0943	0.5	455	TCEQ 2006
tert-Butylbenzene	8260B	2	0.122	2	48	TCEQ 2006
Tetrachloroethene (PCE)	8260B	0.5	0.109	0.5	1450	TCEQ 2006
Toluene	8260B	0.5	0.0975	0.5	480	TCEQ 2006
trans-1,2-Dichloroethene	8260B	0.5	0.143	0.5	23950	TCEQ 2006
trans-1,3-Dichloropropene	8260B	0.5	0.0863	0.5	--	--
Trichloroethene (TCE)	8260B	0.5	0.118	0.5	970	TCEQ 2006
Trichlorofluoromethane	8260B	0.5	0.131	0.5	871	TCEQ 2006
Vinyl Chloride	8260B	0.5	0.211	0.5	2820	TCEQ 2006
<b>Organochlorine Pesticides (µg/L)</b>						
2,4'DDD	8081A	1	0.0008	0.01	--	NA
2,4'DDE	8081A	1	0.0008	0.01	--	NA

**Table 5**  
**Parameters for Analysis, Methods, and Practical Quantitation Limits for Porewater Samples**

Chemical Parameter	Analytical Method	Practical Quantitation Limits	MDL	MRL	Water Quality Criteria	WQC Source
2,4'DDT	8081A	1	0.001	0.01	--	NA
4,4'DDD	8081A	1	0.001	0.01	0.025	TCEQ 2006
4,4'DDE	8081A	1	0.001	0.01	0.14	TCEQ 2006
4,4'DDT	8081A	1	0.0006	0.01	0.001	TCEQ 2006
Total DDT	8081	1	0.01	0.01	--	NA
<b>Polychlorinated Biphenyl (PCB) Compounds (µg/L)</b>						
PCB Congeners (1-209)	1668A	500	100	500	0.03	TCEQ 2006

Notes:

1 - Criterion is salinity, temperature, and pH dependent (range 0.67 to 777 mg/L NH<sub>4</sub>-N)

NA - Not applicable

MDL - Method Detection Limit

MRL - Method Reporting Limit

ppm - Parts per million

µg/L - micrograms per liter

pg/L - picograms per liter

CAS-SOP - Columbia Analytical Services SOP

Surg - Surrogate standard

NRWQC - USEPA. 2006. National Recommended Water Quality Criteria. USEPA Office of Water, Office of Science and Technology, 4304T, 2006.

USEPA. 2003. Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: PAH Mixtures. USEPA Office of Research and Development, Washington, DC, EPA-6--0R-02-013, Table 3-4, PAH Specific Final Chronic Values.

TCEQ. 2006. Update to Guidance for Conducting Ecological Risk Assessments at Remediation Sites In Texas RG-263 (Revised). Remediation Division. January. <http://www.tceq.state.tx.us/assets/public/remediation/eco/0106eragupdate.pdf>

\* Methyl mercury - 500 ml fluoropolymer bottle, HCl preservation for groundwater, saline waters H<sub>2</sub>SO<sub>4</sub> preservation.

-- - Not available

**Table 6**  
**Parameters for Analysis, Methods, and Practical Quantitation Limits for Sediment Samples**

Chemical Parameter	Analytical Method	Practical Quantitation Limits	MDL	RL	Sediment Quality Guidelines*	
					PEL	TEL
Metals (mg/kg dry weight, ppm)						
Mercury	7471A	0.14	0.008	0.02	0.486	0.13
Methyl Mercury	1631/CAS-SOP	0.0001	0.00004	0.0001	--	--
Arsenic, total	6020	0.5	0.07	0.5	41.6	7.24
Barium, total	6010B / 6020	0.3	0.03	0.05	--	--
Cadmium, total	6020	0.05	0.007	0.05	4.21	0.676
Chromium, total (III + VI)	6020	2	0.04	0.2	160.4	52.3
Copper, total	6020	0.2	0.02	0.1	108.2	18.7
Lead, total	6020	2	0.02	0.05	112.2	30.2
Nickel, total	6020	0.2	0.04	0.2	42.8	15.9
Selenium, total	7000 series GFAA	1	0.2	1	--	--
Silver, total	6020	0.02	0.003	0.02	1.77	0.73
Zinc, total	6020	0.6	0.2	0.5	271	124
Nonionizable Organic Compounds (µg/kg dry weight)						
Aromatic Hydrocarbons						
Low Molecular Weight PAH						
Naphthalene	8270C/SIM	6.7	0.33	5	390.6	34.6
Acenaphthalene	8270C/SIM	6.7	0.22	5	127.9	5.9
Acenaphthene	8270C/SIM	6.7	0.16	5	88.9	6.7
Fluorene	8270C/SIM	6.7	0.19	5	144.4	21.2
Phenanthrene	8270C/SIM	6.7	0.33	5	515	86.7
Anthracene	8270C/SIM	6.7	0.22	5	245	46.9
2-Methylnaphthalene	8270C/SIM	6.7	0.34	5	201.3	20.2
1-Methylnaphthalene	8270C/SIM	6.7	0.25	5	--	--
High Molecular Weight PAH						
Fluoranthene	8270C/SIM	6.7	0.34	5	2,355	112.8
Pyrene	8270C/SIM	6.7	0.36	5	875	152.7
Benz(a)anthracene	8270C/SIM	6.7	0.16	5	385	74.8
Chrysene	8270C/SIM	6.7	0.41	5	862	107.8
Benzo(k)fluoranthene		6.7	0.33	5	--	--
Benzo(a)pyrene	8270C/SIM	6.7	0.22	5	782	88.8
Benzo(e)pyrene	8270C/SIM	6.7	0.39	5	--	--
Indeno(1,2,3-cd) pyrene	8270C/SIM	6.7	0.24	5	--	--
Benzo(b)fluoranthene	8270C/SIM	6.7	0.48	5	--	--
Dibenz(a,h)anthracene	8270C/SIM	6.7	0.26	5	134.6	6.2
Benzo(g,h,i)perylene	8270C/SIM	6.7	0.23	5	--	--
Perylene	8270C/SIM	6.7	0.17	5	--	--
Alkyl-substituted PAH homologs						
C1-Naphthalenes	8270C/ SIM	6.7	5	5	--	--
C1-Chrysenes	8270C/ SIM	6.7	5	5	--	--
C1-Fluoranthenes/Pyrenes	8270C/ SIM	6.7	5	5	--	--
C1-Fluorenes	8270C/ SIM	6.7	5	5	--	--
C1-Phenanthrenes/Anthracenes	8270C/ SIM	6.7	5	5	--	--
C2-Chrysenes	8270C/ SIM	6.7	5	5	--	--
C2-Fluorenes	8270C/ SIM	6.7	5	5	--	--
C2-Naphthalenes	8270C/ SIM	6.7	5	5	--	--
C2-Phenanthrenes/Anthracenes	8270C/ SIM	6.7	5	5	--	--
C3-Chrysenes	8270C/ SIM	6.7	5	5	--	--
C3-Fluorenes	8270C/ SIM	6.7	5	5	--	--

**Table 6**  
**Parameters for Analysis, Methods, and Practical Quantitation Limits for Sediment Samples**

Chemical Parameter	Analytical Method	Practical Quantitation Limits	MDL	RL	Sediment Quality Guidelines*	
					PEL	TEL
C3-Naphthalenes	8270C/ SIM	6.7	5	5	--	--
C3-Phenanthrenes/Anthracenes	8270C/ SIM	6.7	5	5	--	--
C4-Chrysenes	8270C/ SIM	6.7	5	5	--	--
C4-Naphthalenes	8270C/ SIM	6.7	5	5	--	--
C4-Phenanthrenes/Anthracenes	8270C/ SIM	6.7	5	5	--	--
<b>Misc. Semivolatile Organics (µg/kg dry weight)</b>						
Hexachlorobenzene	8081A	1	0.55	5	--	--
Hexachlorobutadiene	8081A	1	0.52	5	--	--
bis(2-Ethylhexyl)phthalate	LL-8270	200	1.7	200	2646.5	182.2
Butylbenzylphthalate	LL-8270	10	1.5	10	--	--
Diethylphthalate	LL-8270	10	3.5	10	--	--
Dimethylphthalate	LL-8270	10	1.8	10	--	--
Di-n-butylphthalate	LL-8270	10	2.6	10	--	--
Di-n-octylphthalate	LL-8270	10	1.2	10	--	--
<b>Organochlorine Pesticides (µg/L)</b>						
2,4'DDD	8081A	1	0.16	1	--	--
2,4'DDE	8081A	1	0.069	1	--	--
2,4'DDT	8081A	1	0.08	1	--	--
4,4'DDD	8081A	1	0.09	1	7.81	1.2
4,4'DDE	8081A	1	0.1	1	374.2	2.1
4,4'DDT	8081A	1	0.2	1	4.7	1.2
Total DDT	8081	1		1	51.7	3.89
<b>Polychlorinated biphenyl (PCB) compounds (µg/kg dry weight)</b>						
PCB Congeners (1-209)	1668A	12.5	0.005	0.05	188.8	21.55
<b>Radioisotopes (pCi/g dry)</b>						
Lead-210	Radiochemical Separation*	0.1	0.1	NA	NA	NA
<b>Conventional Sediment Parameters (% wet weight)</b>						
Total Organic Carbon (TOC)	ASTM D4129-82M	0.1	0.02	0.0500	NA	NA
Water Content	ASTM D 2216	0.1	NA	NA	NA	NA
<b>Physical Tests</b>						
Grain Size	ASTM D 422	NA	NA	NA	NA	NA
Atterberg Limits	ASTM D 4318	NA	NA	NA	NA	NA
Specific Gravity	ASTM D 854	NA	NA	NA	NA	NA
CU Triaxial Compression	ASTM D 4767	NA	NA	NA	NA	NA
Oedometer Consolidation	ASTM D 2435	NA	NA	NA	NA	NA
Flume Testing	McNeil et al. (1996)	NA	NA	NA	NA	NA
Seepage Induced Consolidation (SIC)	Zindarcic (1994)	NA	NA	NA	NA	NA

Notes:

ASTM - American Society of Testing and Materials

CU - Consolidated undrained

NA - Not applicable

PEL - Probable Effects Level ()

MDL - Method detection limit

RL - Reporting limit

ppm - Parts per million

µg/kg - micrograms per killogram

ng/kg - nanograms per killogram

pCi/g - picocuries per gram

TEL - Threshold Effects Level (for Freshwater Sediment)

CAS-SOP - Columbia Analytical Services SOP

-- - Not available

\*Source: Buchanan, M.F. 1999. NOAA Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Seattle, WA, Coastal Protection and Restoration Division, National Ocean

**Table 7**  
**Laboratory Quality Control Sample Summary**

<b>Analysis Type</b>	<b>Initial Calibration</b>	<b>Ongoing Calibration</b>	<b>Standard Reference Material or LCS/LCSD</b>	<b>Replicates</b>	<b>Matrix Spikes</b>	<b>Matrix Spike Duplicates</b>	<b>Method Blanks</b>	<b>Surrogate Spikes</b>
Grain size	Each batch <sup>a</sup>	NA	NA	1 per 20 samples	NA	NA	NA	NA
Metals	Daily or each batch	1 per 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	NA	Each batch	NA
Mercury	Daily or each batch	1 per 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	NA	Each batch	NA
Methyl Mercury	Daily or each batch	Mid-batch	Each batch	1 per 20 samples	1 per 10 samples	1 per 10 samples	Each batch	NA
Radiochemistry	Yearly	Twice weekly	1 per 20 samples <sup>e,f</sup>	1 per 20 samples	1 per 20 samples <sup>e,f</sup>	1 per 20 samples <sup>e,f</sup>	1 per 20 samples <sup>e,f</sup>	NA
Polychlorinated biphenyls	As needed <sup>c</sup>	1 per 10 samples	1 per 20 samples	NA	1 per 20 samples	1 per 20 samples	Each batch	Every sample
Organochlorine pesticides	As needed <sup>c</sup>	1 per 10 samples	1 per 20 samples	NA	1 per 20 samples	1 per 20 samples	Each batch	Every sample
SVOC	As needed <sup>c</sup>	1 per 10 samples	1 per 20 samples	NA	1 per 20 samples	1 per 20 samples	Each batch	Every sample
VOC	As needed <sup>c</sup>	Every 12 hours	1 per 20 samples	NA	1 per 20 samples	1 per 20 samples	Each batch	Every sample

Notes:

a Calibration and certification of drying ovens and weighing scales are conducted bi-annually.

b Initial calibration verification and calibration blank must be analyzed at the beginning of each batch.

c Initial calibrations are considered valid until the ongoing continuing calibration no longer meets method specifications. At that point, a new initial calibration is performed.

d Scale should be calibrated with class 5 weights daily, weights must bracket the weight of sample and weighing vessel.

e Standard reference material is not applicable for this analysis. There is also no surrogate spike to be used for the analysis

f If sufficient material is available

NA Not applicable

LCS Laboratory control sample / laboratory control sample duplicate

**Table 8**  
**Laboratory Measurement Objectives for Porewater, Sediment, and Sediment Trap Samples**

Parameter	Precision	Accuracy	Completeness
Grain size	+/- 20% RPD	NA	95%
Metals	+/- 20% RPD	65-130% R	95%
Radiochemistry	+/- 25% RPD	65-135% R	95%
Organochlorine pesticides	+/- 50% RPD	50-140% R	95%
Polychlorinated biphenyls	+/- 50% RPD	50-140% R	95%
SVOC	+/- 50% RPD	50-140% R	95%
VOC	+/- 50% RPD	50-140% R	95%

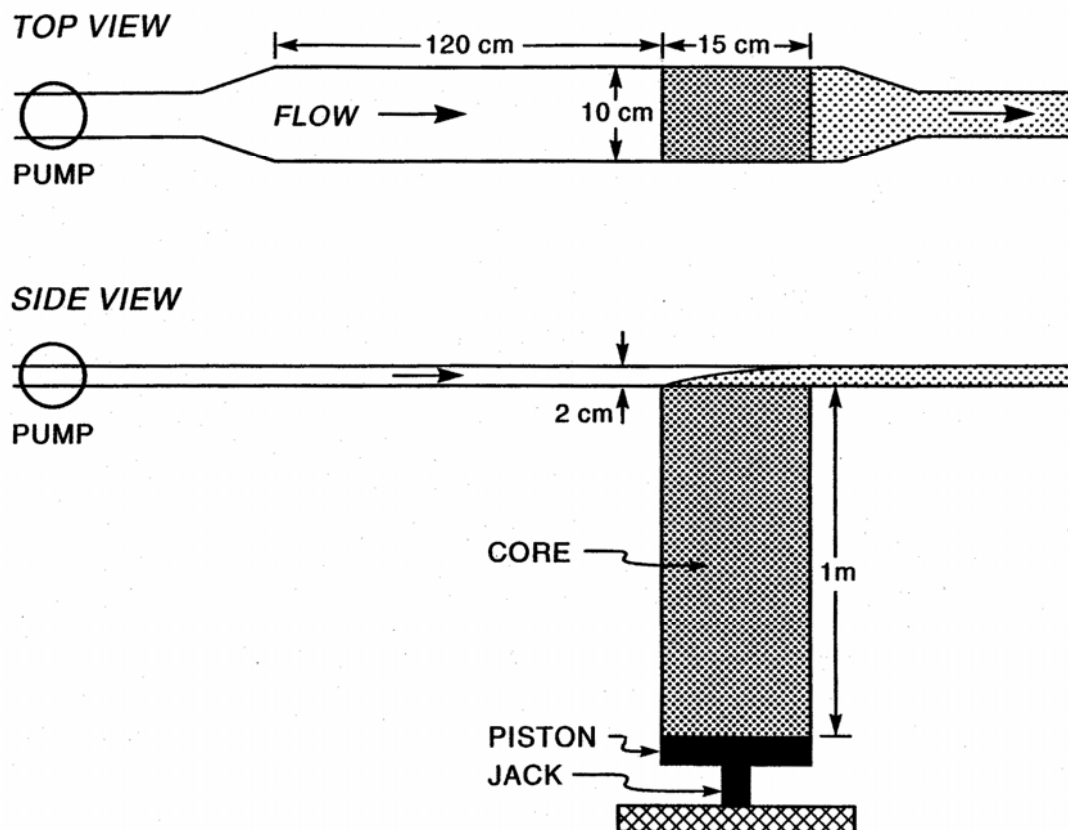
Notes:

RPD    Relative percent difference  
R       Recovery

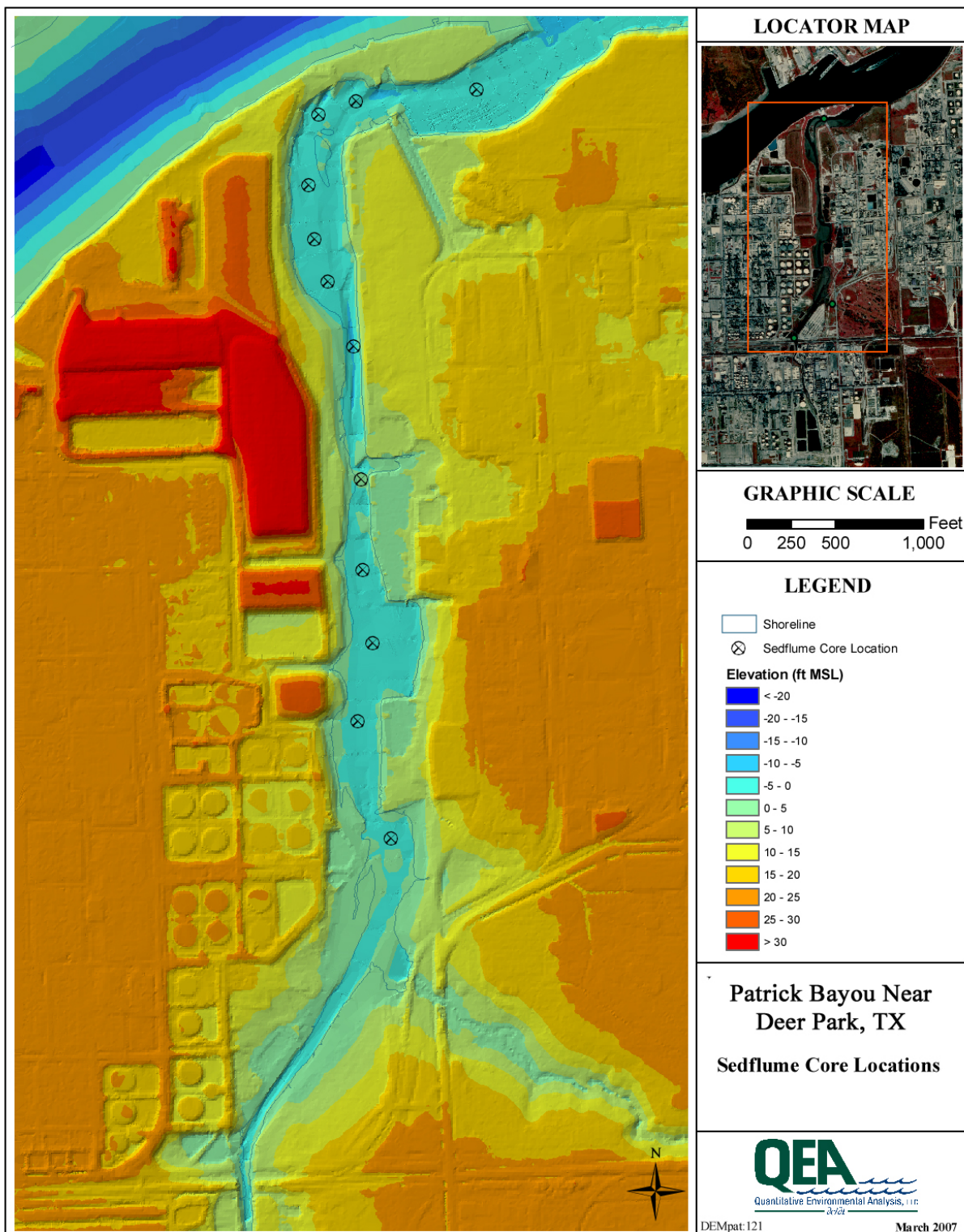
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## FIGURES

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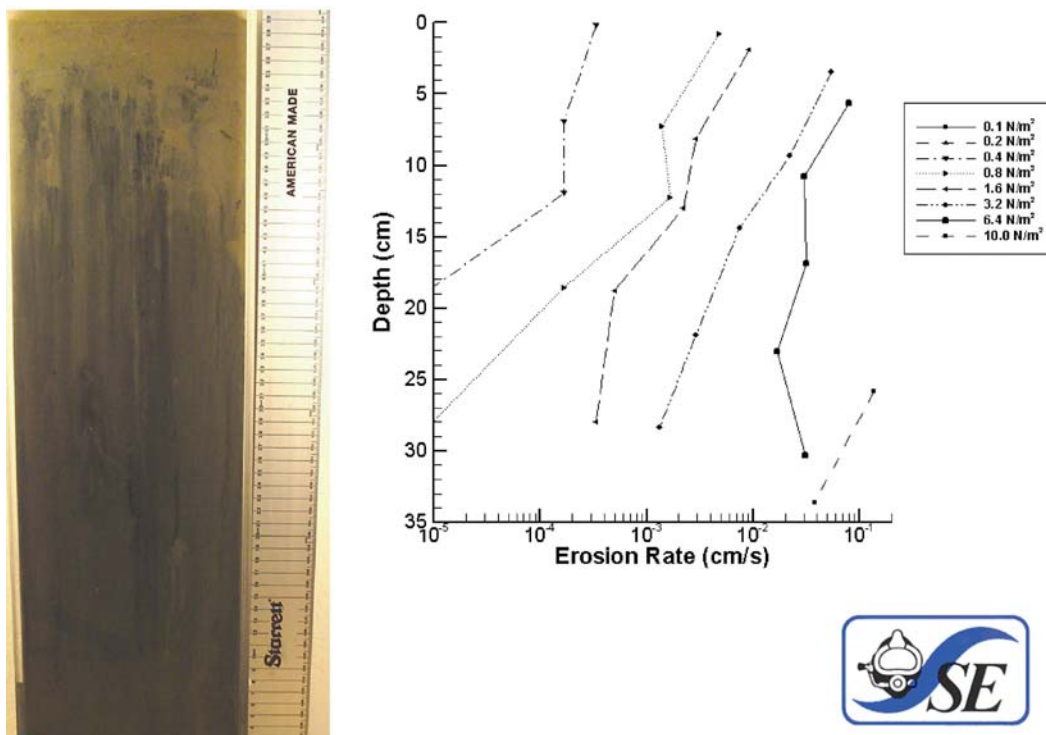


**Figure 1**  
Schematic of Sedflume  
Patrick Bayou Supplemental RI Work Plan

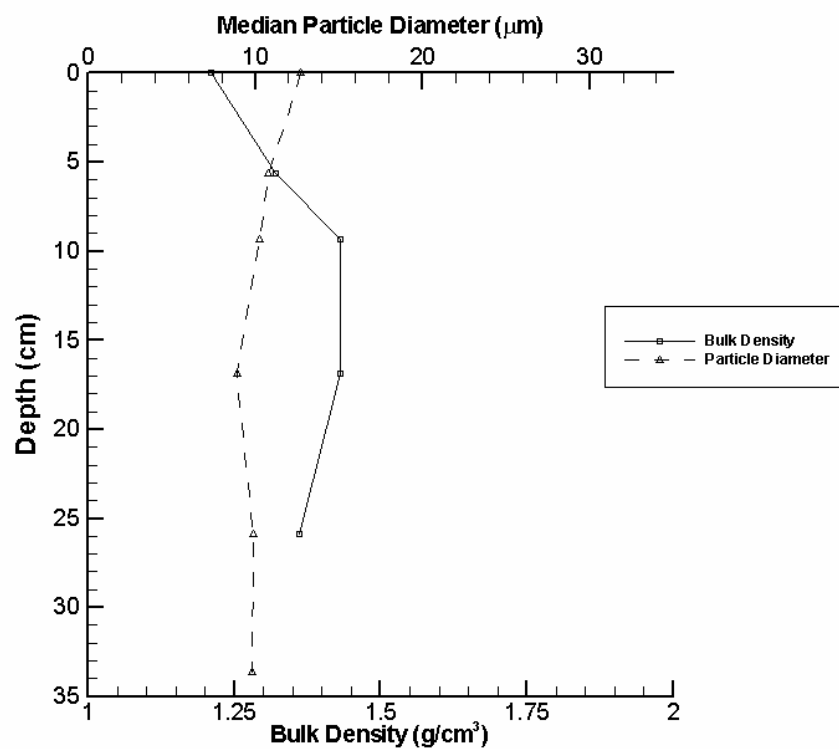


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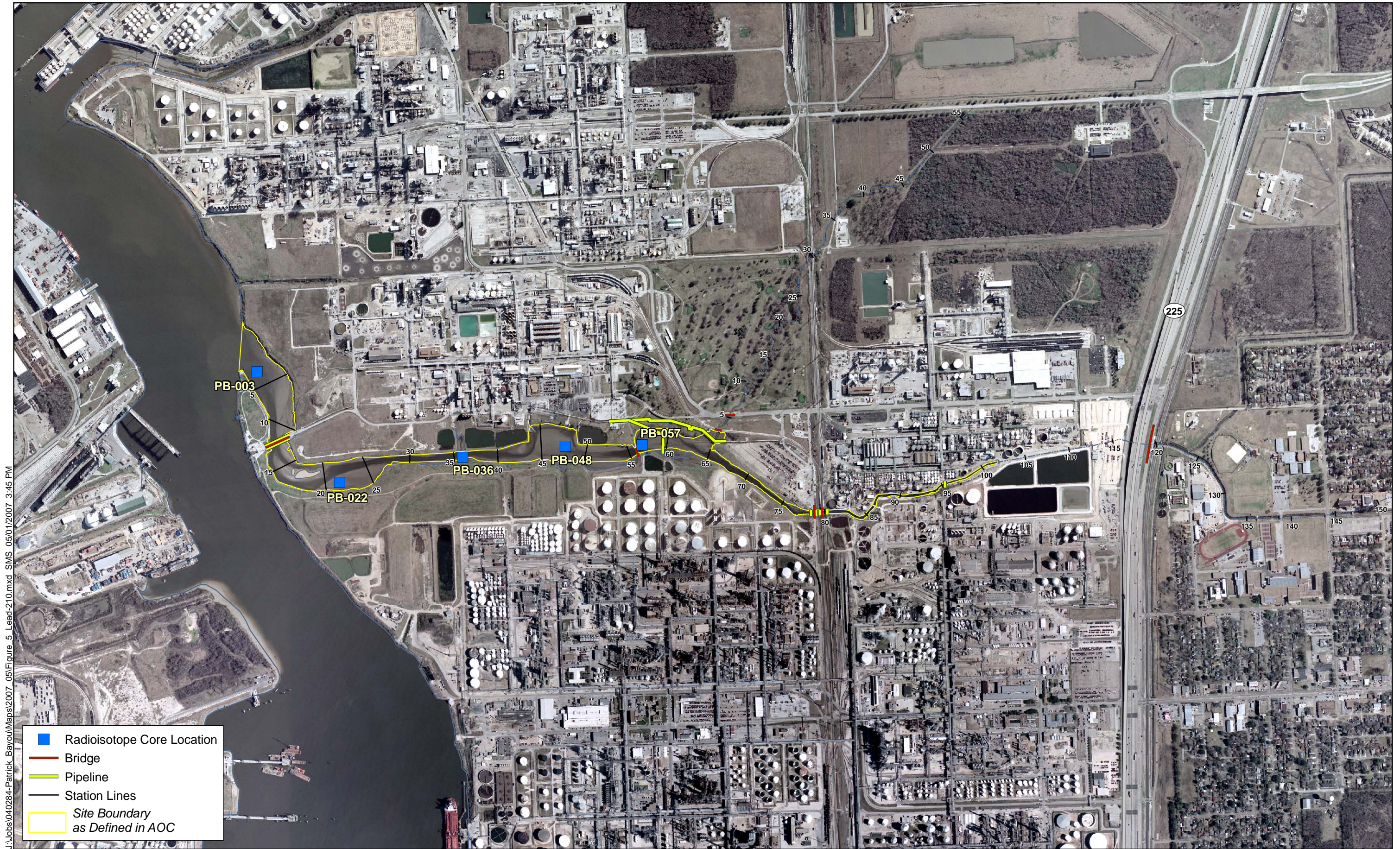
DRAFT - SUBJECT TO REVISION



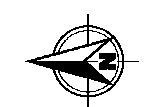
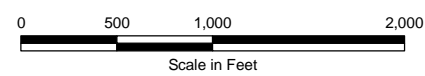
**Figure 3.** Erosion Rate Variation with Depth and Shear Stress for San Francisco Bay Location



**Figure 4.** Variation of Particle Size and Bulk Density with Depth for San Francisco Bay Location



J:\Jobs\040284-Patrick Bayou\Maps\2007\_05\Figure 5 Lead-210.mxd SMS 05/01/2007 3:45 PM



Station numbers from Patrick Bayou PSCR indicate length along channel in hundreds of feet. Aerial orthoimagery from USGS, June 2002.

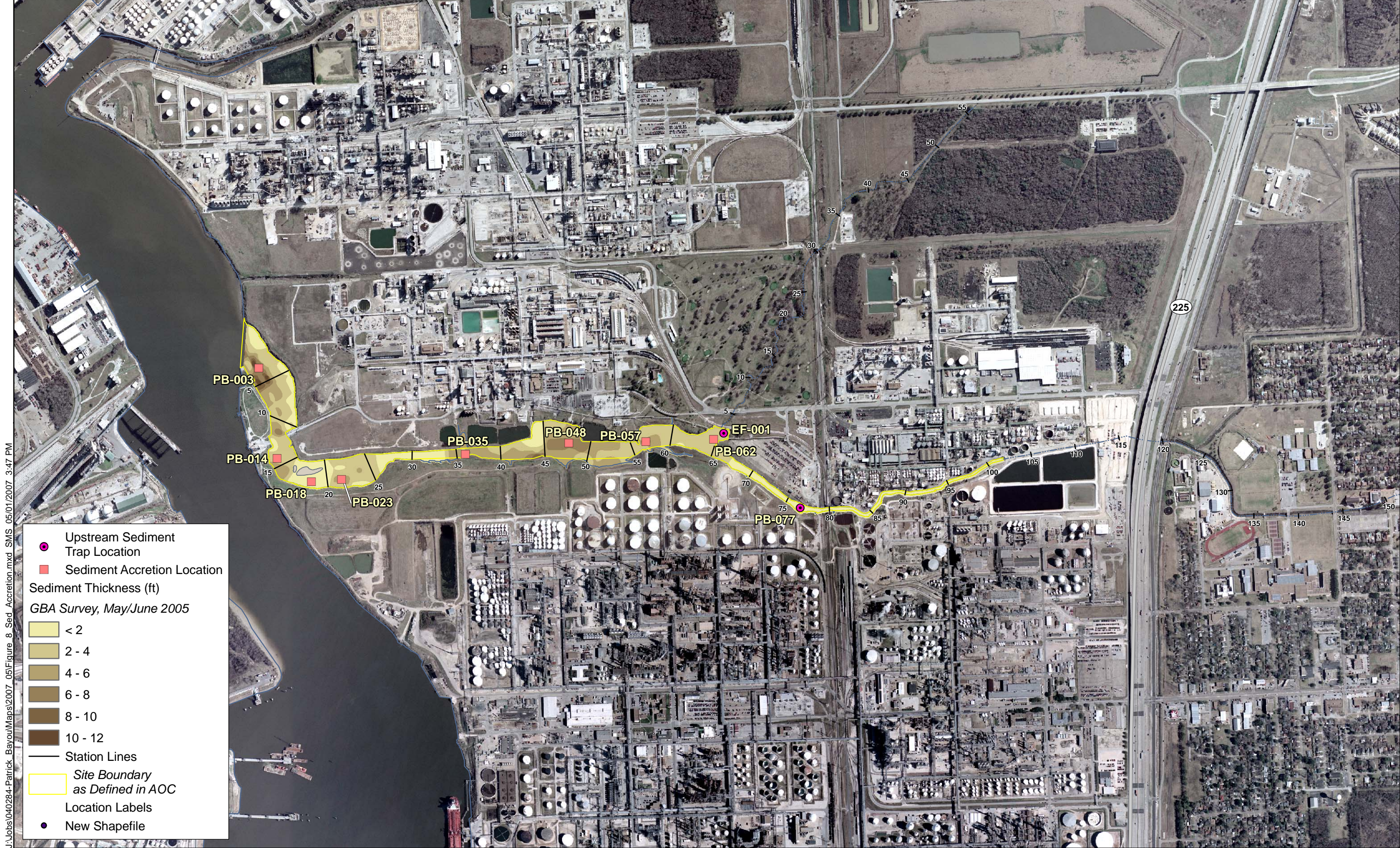
**Figure 5**  
Locations of Collection of Archived Core Materials for Lead-210 Analyses  
Patrick Bayou Supplemental RI Work Plan



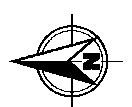
(Courtesy of USGS)



(Courtesy of USGS)



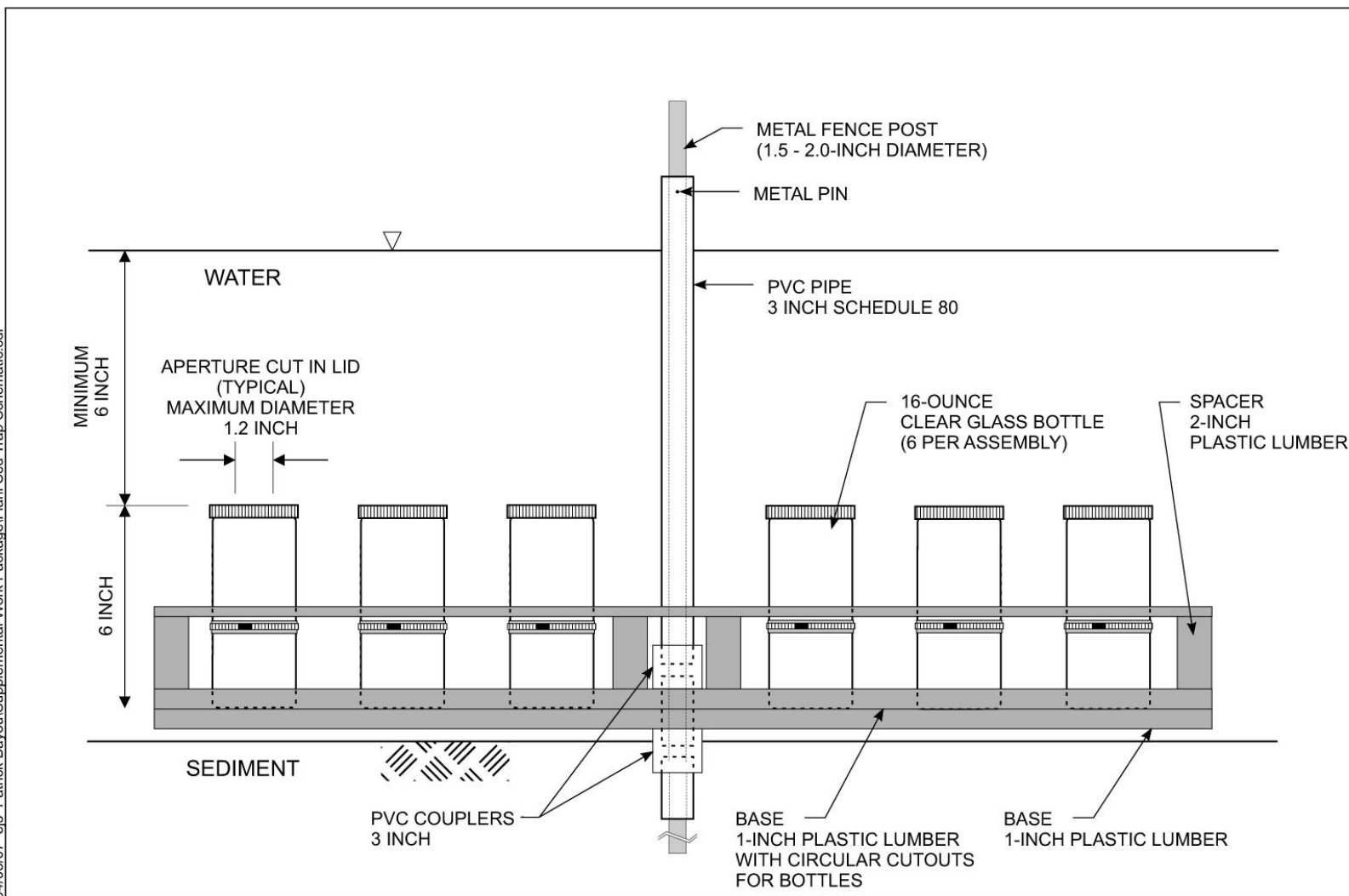
J:\Jobs\040284-Patrick Bayou\Maps\2007\_05\Figure 8 Sed Accretion.mxd SMS 05/01/2007 3:47 PM

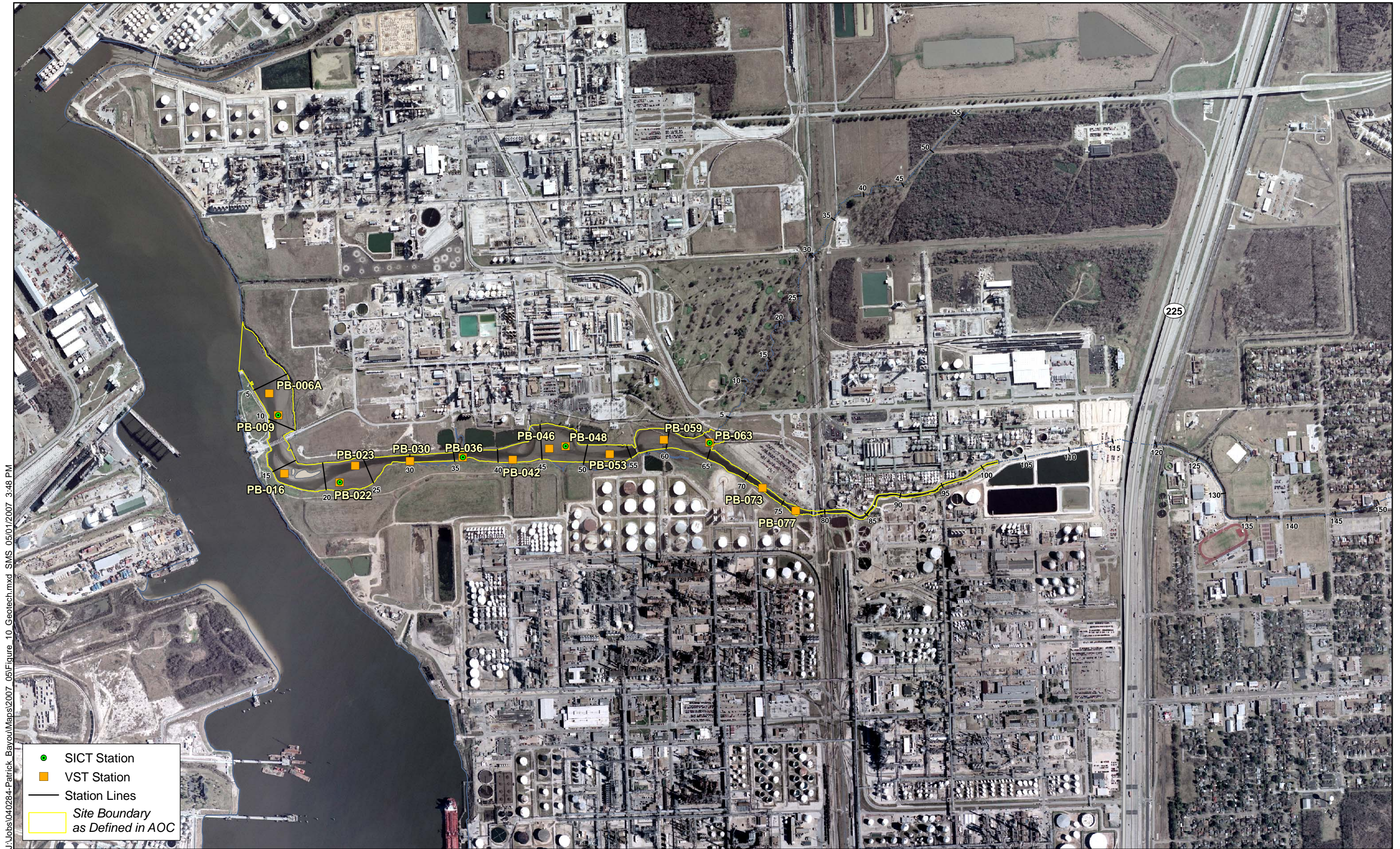


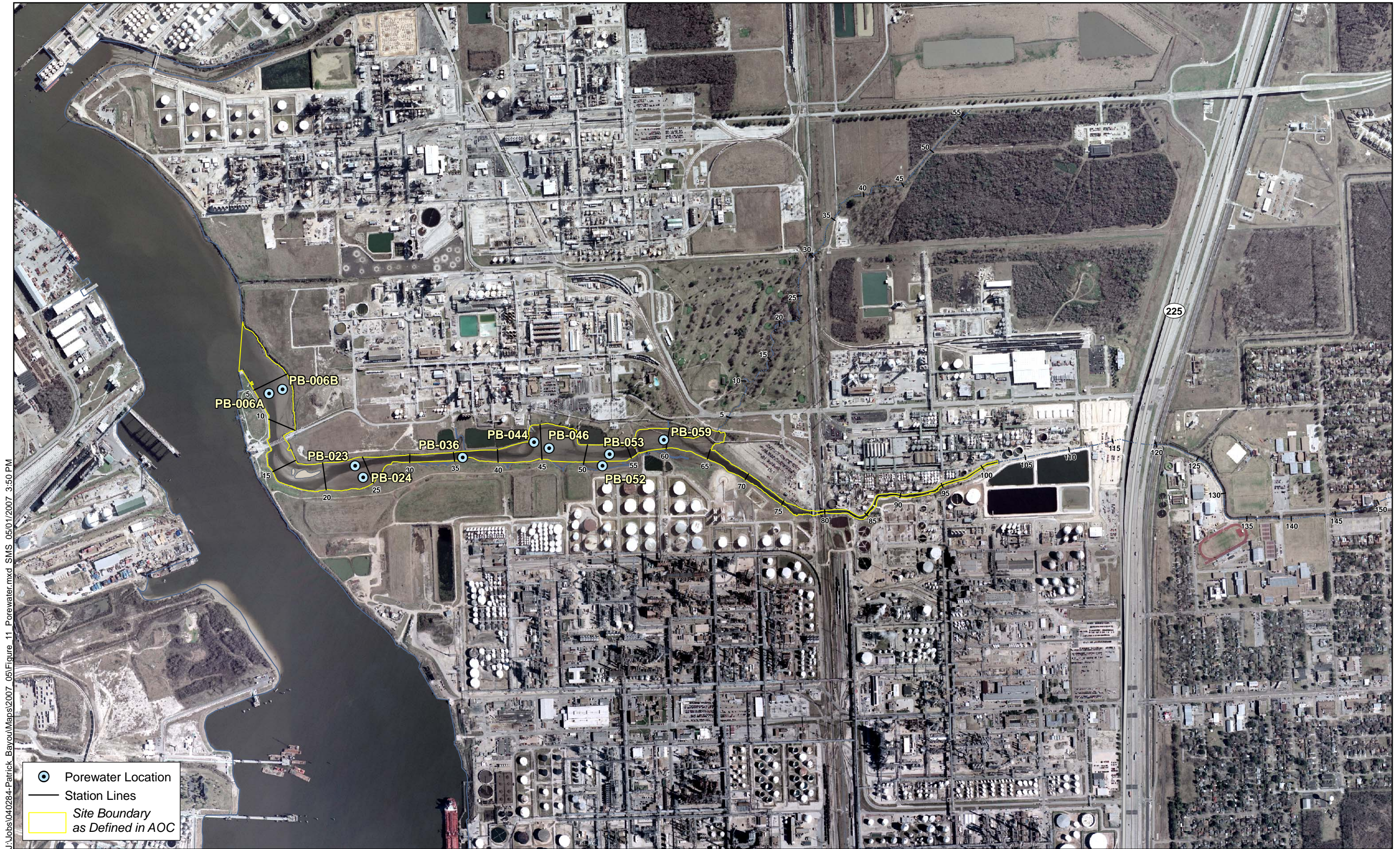
Station numbers from Patrick Bayou PSCR indicate length along channel in hundreds of feet. Aerial orthoimagery from USGS, June 2002.

**Figure 8**  
Accretion Measurement and Upstream  
Sediment Trap Station Locations  
Patrick Bayou Supplemental RI Work Plan

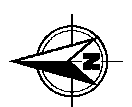
04/05/07 ejs Patrick Bayou\Supplemental Work Package\Final Sed Trap Schematic.cdr







J:\Jobs\040284-Patrick Bayou\Maps\2007\_05\Figure 11\_Porewater.mxd SMS 05/01/2007 3:50 PM



Station numbers from Patrick Bayou PSCR  
indicate length along channel in hundreds of feet.  
Aerial orthoimagery from USGS, June 2002.

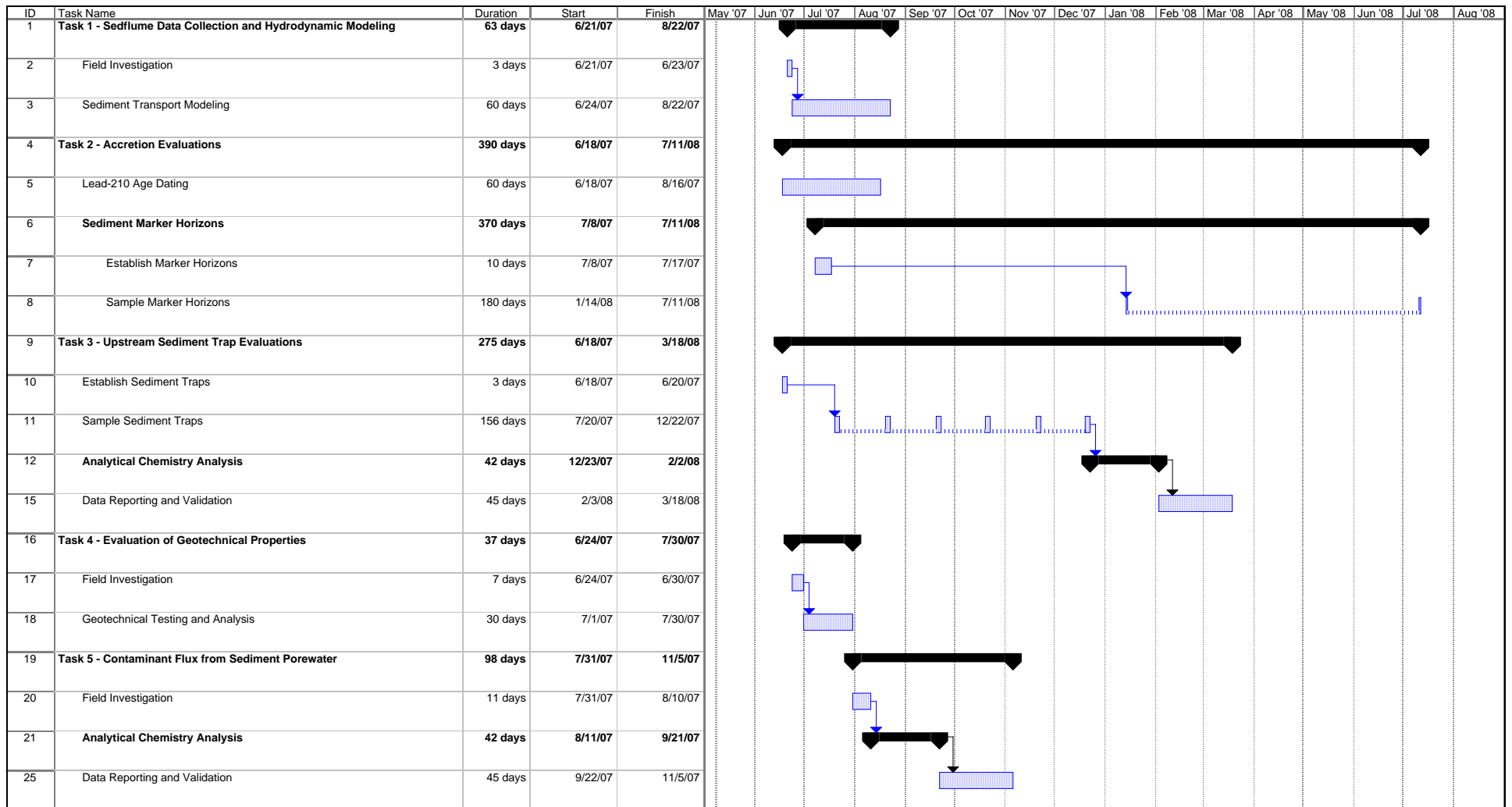
**Figure 11**  
Porewater Sampling Locations  
Patrick Bayou Supplemental RI Work Plan

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**APPENDIX A**

**PROPOSED SCHEUDULE OF FIELD AND LABORATORY ACTIVITIES**

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Appendix A - Patrick Bayou Supplemental Workplan Schedule

Task

Split

Progress

Milestone

Summary

Project Summary

External Tasks

External Milestone

Deadline

Page 1

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## **APPENDIX B**

### **SEDIMENT ACCRESTION MEASUREMENT TECHNIQUES**

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## **B.1 INTRODUCTION**

This appendix provides a description sediment accretion measurement techniques planned for use in further investigations of the processes of sedimentation and erosion at the Site. The information generated will allow improved assessment of the potential for monitored natural recovery (MNR) and sediment capping techniques as remedial techniques for use within the Site.

Sediment accretion measurement techniques have been widely used in coastal environments, particularly in the southeastern United States. The focus of this work has been on the investigation of sediment erosion and deposition in coastal Louisiana marshes and wetlands. Techniques presently used by the Louisiana Department of Natural Resources (LDNR) Coastal Restoration Division employ the use of feldspar marker horizons to monitor changes in sedimentation rates. Both techniques were developed in part by Cahoon and others (full citations for all references in this appendix are provided in the text of the Supplemental Work Plan). The feldspar marker horizon approach (Cahoon and Turner 1989) has been further refined by the addition of a cryogenic method developed by Cahoon et al. (1996).

Marker horizons for estimation of sedimentation rates have been in use for several decades. Questions surrounding data interpretation have focused on errors associated with coring and core interpretation due to the soft nature of sediments in depositional environments. The addition of the cryogenic method for data collection has eliminated many of the issues associated with core collection and interpretation, and allows a high degree of accuracy when marker horizon stations are sampled (Folse and West 2004).

## **B.2 HORIZONTAL MARKER DATA COLLECTION**

Estimates of rates of sediment accretion or erosion are measured by the establishment of marker horizon stations systematically placed around a boardwalk. The marker horizon is white feldspar clay that is evenly sprinkled over a 0.5 meter square sediment surface area. Marker horizons are typically established with a minimum of three replicates. At 6 and 12 months after establishment, the stations are sampled using a cryogenic method developed by Cahoon et al. (1996).

**Materials List**

Materials needed for marker horizon station establishment include:

1. Feldspar (G-200 white feldspar clay from the Feldspar Corporation, Minspar 200 or equivalent; minimum 80 ounces or 5 mm thickness per station; five to six stations per 50 pound bag)
2. 50 cm x 50 cm PVC square or a large plastic container of equivalent size to assist in establishing feldspar layer
3. PVC pipe or other material to mark station locations
4. Spreader/Sieve to evenly spread the feldspar within the station
5. Respirator to prevent the inhalation of the feldspar clay; gloves and eye protection are also recommended
6. Watering can or sprayer to moisten the feldspar on dry sediment without disrupting feldspar layer
7. Digital camera with date and time stamp to document station establishment
8. Differential global positioning system (GPS) for station coordinates (verification and identification)

**Field Station Establishment**

In locations where vegetation is established or is likely to become established, it is recommended that marker horizon layers are set up in late winter or early spring (February and March) to minimize the potential effects of plant growth on data collection efforts. Station establishment is conducted from a constructed boardwalk to minimize impacts on field measurements over time. A minimum of two station markers is recommended to ensure that the station can be resampled accurately. Each marker horizon should consist of a minimum thickness of 5 millimeters (mm) of feldspar (approximately 80 ounces or 2.27 kg of feldspar clay).

If the sediment surface is exposed on the day of the station establishment, the feldspar should be consolidated by gentle sprinkling with water, taking special care to avoid creation of areas of exposed sediment or a thicker feldspar layer.

If the station is to be established on submerged sediment, a plastic container with a 0.5 meter square area, such as a trashcan, with the bottom cut out, is placed on the sediment surface and

pushed in to the mud to slightly penetrate the surface prior to application of the feldspar clay to the sediment surface; remove the barrier when all the feldspar has settled (generally 15 minutes post application).

### **Data Collection**

Sampling of marker horizon stations typically occurs at 6 and 12 months after establishment. The bright white feldspar marker layer should be readily distinguishable from the surrounding sediment constituents in sample cores. Rates of accretion/erosion are determined for the site by measuring the amount of deposition above the horizon marker and the dates of station establishment and sampling.

### **Materials List**

Use of the Cahoon et al. (1996) cryogenic technique that employs liquid nitrogen to freeze a small sediment core allows for relatively easy extraction of an intact sediment sample and the recording of a set of four equally spaced measurements of the length of the core from the feldspar layer to the surface. Materials needed include:

1. Liquid nitrogen Dewar and hose assembly
2. Cryoprobes for use in core sampling
3. 50 cm x 50 cm PVC square (sampling grid)
4. Calipers: High quality stainless steel that measures up to 150 millimeters (mm) in increments of 0.02 mm
5. Random sampling locations within the station area
6. Personal Protection Equipment (especially gloves and eye protection)

### **Procedures**

Random sampling locations will be determined using a pre-selected set of random coordinates and a 50 cm x 50 cm square with four evenly spaced markings on all sides. These markings will be used to determine where the sampling will occur in the station.

Accurate field records will be used to ensure that samples will not be taken from previously sampled locations on repeat sampling events.

Liquid nitrogen is introduced to the sediment using a “bullet” (cryoprobe); the final product is a frozen sediment core (“cryo-core” or “marshsicle”; the terms are interchangeable, though the latter tends to be used in less formal field settings). Measurements and notes will be taken on this core. Data include station information plus the condition of the feldspar found in the cyper-core, as well as the condition of the core itself. If the feldspar is highly visible around the entire sample, the core is considered to be in excellent condition; however, if the feldspar is obscured or visible for less than the entire circumference of the core then the sample is recorded as being good to poor depending on how much feldspar is visible, or if no feldspar visible. If the cyro-core is in poor condition or the feldspar can not be found then another sample shall be taken.

If possible, four measurements at right angles to each other of the distance from the feldspar layer to the sediment surface are made, using calipers, to the nearest 0.02 mm. If four measurements cannot be taken, then no less than three readings of the distance should be recorded. Readings of zero are recorded only when the feldspar is visible on the surface or when the feldspar is visible but there is no measurable sediment on top.

When measurements are complete, the core is returned to the sediment surface to minimize disturbance to the area where the sample was taken. Practical experience with the technique indicates that if two consecutive coring attempts are made and no feldspar is seen on the cyro-core, then sampling at the station should be discontinued.

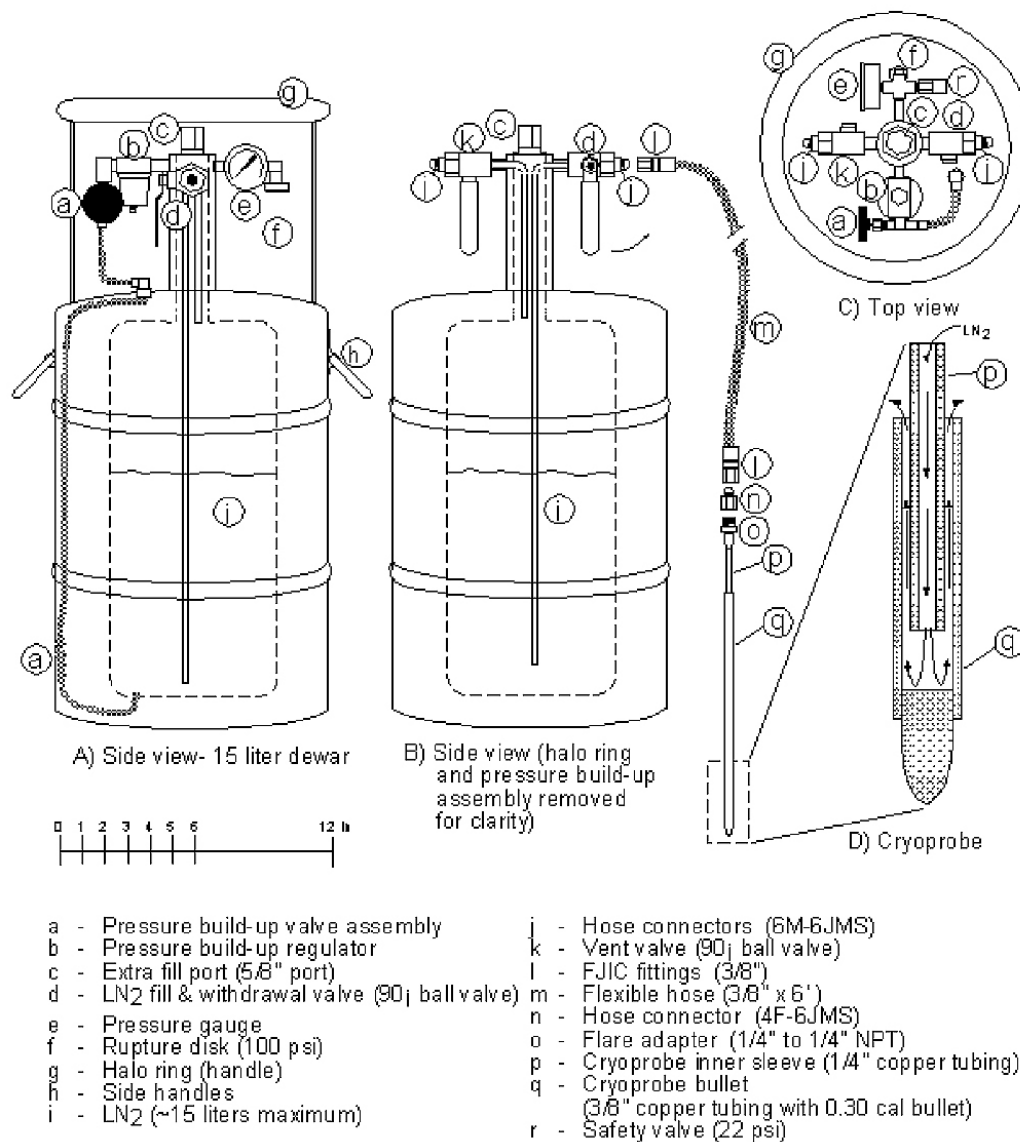
Before leaving each site, field data sheets are to be examined for clarification and completion. Any information that was not completed on the boardwalk should be completed prior to leaving the area.

If feldspar is still visible on the sediment surface at the time of sampling, record the coordinates and verify that the feldspar is still on the surface and note this for the station without collecting a cryo-core. If physical processes in the environment have deposited layers of unconsolidated sediment and plant matter, or created a void layer or water layer in the cryo-core, accretion should be estimated by only recording the measurement for the material that is consolidated on top of the feldspar (do not include void or water layers).

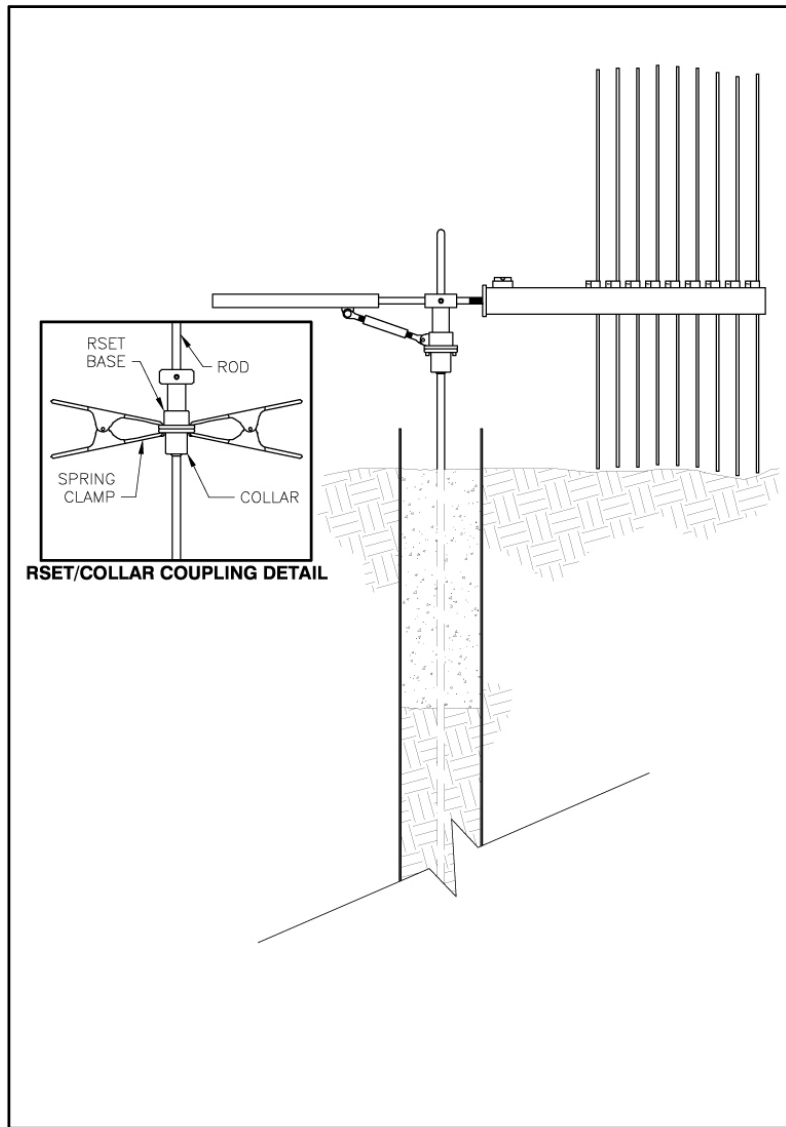
Measuring cyro-cores can be subjective at times. It is highly recommended that the same person measure at all times when possible. Carefully check field data for station information and for completeness. A data sheet tailored to include the information to be recorded at each location is recommended.

### **Data Processing**

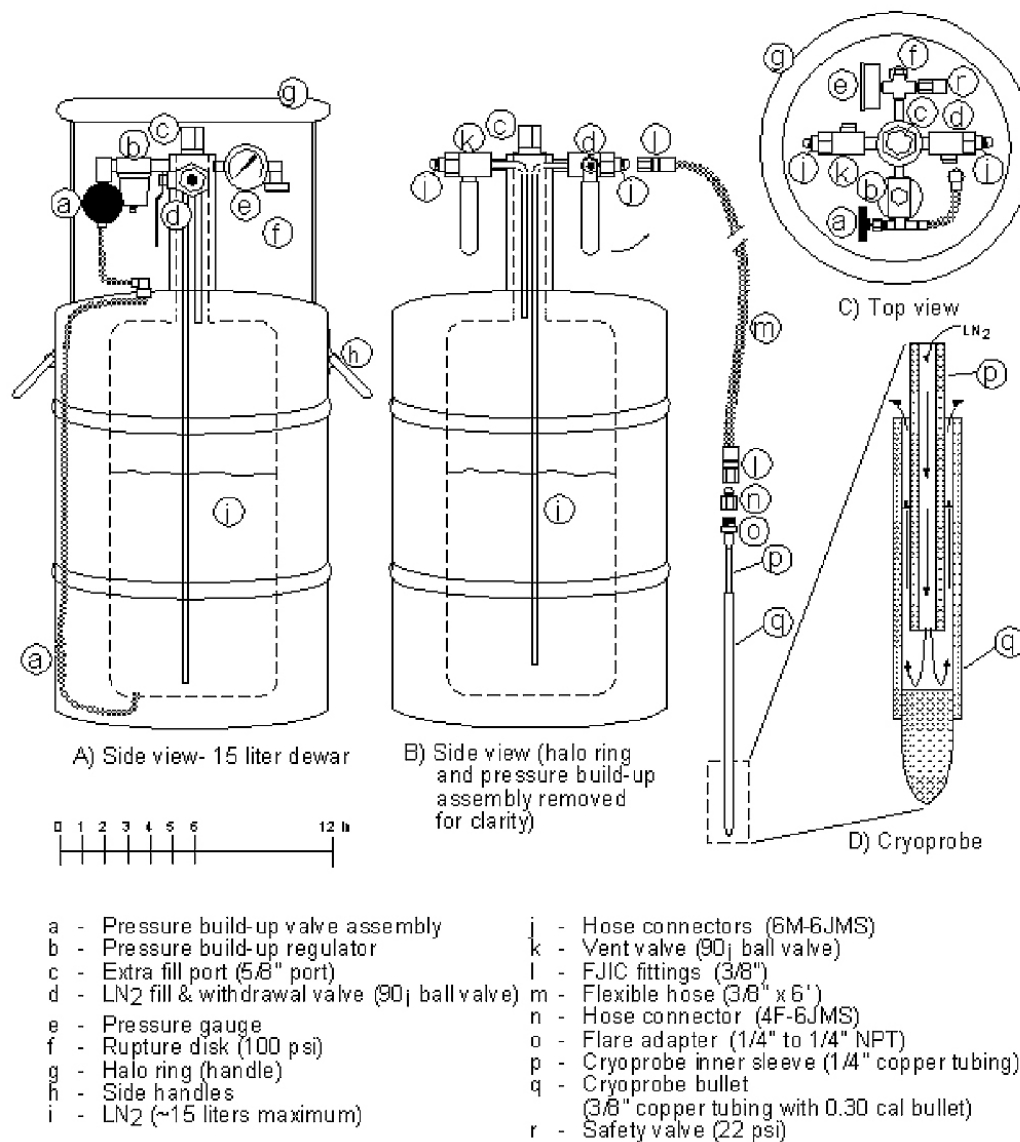
A two phase protocol for data processing consisting of data entry and QA/QC is used to ensure accuracy. Data processing details are summarized in Folse and West (2004), and follow standard field data collection and data entry protocols adhered to in other aspects of the Patrick Bayou RI/FS Work Packages. An Excel template spreadsheet and graphs are used to visually inspect data for outliers or questionable data points. Again, QA/QC focus is on accuracy of data transcription from the field, and records of conditions and observations at the marker horizon locations that may affect measurement results.



Schematic of cryogenic coring device and components developed by Cahoon et al. 1996



Typical RSET data collection schematic



Schematic of cryogenic coring device and components developed by Cahoon et al. 1996